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Macro-Agriculture in the 21st Century China –An Answer to Lester Brown's Three Questions

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Author's contribution

The sole author designed, analyzed and interpreted and prepared the manuscript.

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ABSTRACT

Lester Brown asked "Who will feed China?" 20 years ago and asked "Can the United States Feed China? In March 2011 and wrote another article "Can the World Feed China?" *in* 25 Feb 2014. China is facing two problems: one, population. It is estimated that China's national grain consumption would reach 572.5 million tons by 2020. Although China is largely self sufficient in staple food, it is not in soybeans and corn. When income on average increases, the people need to eat better, to be healthier. How can China feed herself? She should adopt Chinese model. Her economic model must consider resources and environmental carrying capacity in China. China must register zero growth of population in 2030; energy and resources consumption rate in 2040; eco-environmental degradation rate in 2050. The papers retrospect small agriculture, modern agriculture and macro agriculture in China. We must inherit the fine tradition but encourage innovation. Three cases can indicate how to follow up the Tao of agriculture: First, Grain production in moderate scale in Gansu Autonomous Region; second, new discovery of Sea Rice 86 as a special cultivar, and Yuan Longping's super rice yield more than 1500 kg per mu; third, planting rice in arable desert; and new aquaponics technology as reserve resources.

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1. INTRODUCTION:-THREE QUESTIONS FROM LESTER BROWN

20 years ago, in 1994, Lester Brown was the Director of the "World Watch Institute," He wrote an article entitled "Who will feed China?" and published in the Journal of "World Watch". Later it was expanded into a book with the same title, published in late August the same year, only having moderate response from the press. However, when it was published in the Outlook Section of the "Washington Post", the title was altered to be "How can China make the world hungry?" It equaled to put a political fire in Beijing [1].

Nevertheless, Brown's analysis and prediction was not groundless. He saw changes of the economic models in Japan, South Korea and Taiwan. The staple food in these countries (area) was rice, basically self-sufficient, but they later imported all wheat and corn, accounting to 70% of their grain supply for the rapidly growing livestock and poultry industry. Brown thought that this phenomenon from near self-sufficiency in grain to be heavily dependent on imports in the densely populated areas before industrialization was a kind of economic laws.

In March 2011, Brown, put another question "Can America feed China?" on EPI website [2]. The article said, "Chinese leaders assessed the situation, and then decided to make every effort to maintain food self-sufficiency". Government quickly adopted several key measures to boost food production, by abandoning the soybean self-sufficiency, to focus the agricultural resources on the self-sufficiency of remaining crops. Soy bean is a native bean in China and China's neglecting attitude toward soy bean production led to a striking impact. China's decision to import large quantities of soybeans caused the agricultural structure adjustment in Western hemisphere, the only region which can respond to such a huge demand. The soybean fields in the US exceeded its wheat fields. The Brazilian soybean fields exceeded the sum of all grain fields. Argentine soybean land doubled grain land and the country is fast becoming a single soybean planting one. Three soybean producing countries now account for nearly 90% more than 80% of the world crop and soybean exports. Nearly 60 percent of world soybean exports went into China. Brown thought China would likely be to import large quantities of food immediately from the world market soon, if China imports 20% of their need, which requires 80 million tons. This is slightly less than the US annually exports 90 million tons of grain to all countries. To import large quantities of grain, China will inevitably depend on the world's largest food exporter, the United States. For American consumers, the worst nightmare for China may become American nightmare. This is why Brown once again put forth "Can America feed China? "

In 25 February, 2014, Brown raised his third question: "Can the world feed China?" China has become one of the world's major food-importing countries, and in 2013-14 trade years, it purchased a staggering of 22 million tons. According to the latest USDA analysis, China had surplus grain, and exported 10 million tons of grain in 2006, only eight years ago. The world is now changing from abundance to scarcity. According to Michael T. Klare in his book: "The Race for what's Left-The global scramble for the world's last resources" he discussed the Global Land Grabs and the Struggle for Food [3]. In 2008, "European Economy" publicly stated: "Farmland is the new gold"; "safe investment market is not much, but agriculture should be a safe choice." For the King of Saudi Arabia and other government leaders, food shortages expected encouraged buying of farmland, all in order to protect food security. Through the acquisition of land in developing countries, no matter what happened these rulers seek to ensure that their people have food to eat, which means that even the people in supplying countries have nothing to eat. Although Saudi Arabia and the Gulf countries is a foreign land grab instigator, China also follow in their footsteps. Therefore, Brown put forth his third question. China has large population which country can feed. He deliberately raised such kind of three questions and it seems not to be a good intention.

2. SMALL AGRICULTURE IN ANCIENT CHINA

In order to answer how China feed herself, we have to retrospect the history of China to explore how to feed the largest population in ancient times. As is well known, there were four ancient civilizations. In the 4200 years of human history

after entering civilization, the still living one through incessant developing up to date is merely Chinese civilization. For example, in the Tang Dynasty (618-907 BC) of China the population of the capital city, Changan, had 1 million while Rome, the capital of Roman Empire (962-1806） had the population of less than 50,000 only. Supposing somebody in Rome might ask a question “How the Roman Empire could feed China then?” Who would answer that question? Actually, the fact sheet in ancient China answered: the agricultural level in ancient China was very high, not only agricultural production technology was very developed; labour productivity was also higher too. In the Tang Dynasty, the total grain production had already reached 29.7 billion kg. The highest population in the Tang Dynasty was 60,000,000; the grain per person on average was 500 kg.

Historically, China had gone through three agricultural stages: reclaim wasteland and fallow system from the Western Zhou Dynasty (1100-771 B.C.) to the Warring States Period (475-221 B.C.); rotation, multiple cropping system from the Qin Dynasty (221-206 B.C.) to the Sui Dynasty (581-618) and the Tang Dynasties (618-907); rotation, multiple cropping and intercropping systems after the Song Dynasty (960-1127) (1127-1279), which continued to this day [4]. Professor You Xiuling from Zhejiang University thought that the core of the ancient Chinese farming was of ‘Three Essentials’ (Heaven, Earth and Human) theory. It was a philosophy, but also a view of the universe. It came from Yin-Yang theory in the "Book of Changes"; “we put Human between Heaven and Earth”. We discussed agricultural issues by the Tao Theory, such as the 24 solar terms, soil fertility renewable and intensive and meticulous farming. In the “Lv’s Annals” there are four chapters on agriculture to discuss interrelationship among heaven, earth and human. In the Western Han Dynasty (206 B.C.-21 A.D.), "Fan Shang’s Book", the fundamentals for farming was “to fit time, to fit soil and to manure the fields", which is the concretization of ‘Three Essentials’ Theory. This idea handed down through the [Qi Min Yao Shu] (Key Arts for Qi People) (420-581) and other agriculture books. Three Fittings Principles in farming should be another derivative of ‘Three Essentials’ Theory. Its meaning is that agricultural production must be based on changes of climate, geography and the growth law of cultivars and animal species to take corresponding measures. Three Principles should have started in the ‘Spring & Autumn Period’ (770-476 B.C). Ma Yilong, an agronomist in the Ming Dynasty (1368-1644) explained in a more comprehensive and scientific way: "To fit time, to fit space and to fit the properties of organisms, with nothing left, then, work will be half done while credits will be doubled”. All is totally in conformity with today's ecological principles. ‘Three Essentials’ Theory applied in agricultural production led to the theoretical foundation for intensive and meticulous farming, having a huge impact and playing a great role in the development of agricultural production [5].

3. MODERN AGRICULTURE IN THE 20TH C IN CHINA

Agriculture in the 20th Century in China was still a small one or in the transit period from self-sufficiency and self-supporting, small scale to modern agriculture. In September 1954, Premier Zhou Enlai first put forward the concept of "modern agriculture" in the "Government Work Report" made at the first meeting of the First National People's Congress. Mao Zedong knew the importance of science and technology to the development of modern agriculture, strongly advocated for seed selection and improvement in farming methods, and put forward the "Agricultural Eight-Aspect Constitution: Soil - deep plowing, ameliorated soil, soil survey, and land planning; Fertilizer -reasonable fertilization; Water -water conservancy and rational use of water; Species –breeding; Dense – reasonably-dense planting; Protection - pest and disease control; Management - field management and Work – agro-tool reform.” The realization of scientific farming had played a positive role. The agricultural "Eight-Aspect Constitution" increased the yield of crops and affected contemporary agriculture for more than 20 years. It promoted the development of agricultural production in China to a considerable extent. However, during the "Great Leap Forward" campaign in 1958-1960, the distortions and misunderstandings of the "Eight-Aspect Constitution" of agriculture also appeared false and exaggerated, contrary to the objective, economic laws and the law of nature [6].

The Third Plenary Session of CCP held in December 1978 adopted “Reform and Opening Up” policies. China’s internal reform began in rural area and the state insisted to put agriculture on the first place in the modernization, the rural economy had been fully revitalized, grain and cotton production steadily increased, ranking the first in the world, and township enterprises

suddenly emerged, up to 1987, when the output value had exceeded the total agricultural output value. Through Reform and Opening, China had achieved three great turning points:

The first great turning point was from a highly centralized planned economic system to a vibrant and dynamic socialist market economic system; the second, from closed or semi-closed society to all-round open society; the third, people's living are changing from having adequate food and clothing to a fundamentally well-off society and then, gradually becoming prosperous [7].

4. MACRO-AGRICULTURE IN THE 21st CHINA

China has participated in WTO in 11 Dec 2001 as its 143rd member. Entering 21st Century, China is still facing two major problems, namely, the largest population and food security. According to the data published by the State Statistics Bureau in China, the total population in China reached 1,354.040,000 as of 31 Dec 2012 [8]. People would always think how China could feed such a great population. In the 20th century, the Westerners promoted green revolution, actually petro-agriculture largely applying fertilizers, pesticides, herbicides from fossil fuel industry, using agro-machines in large-scale for mechanized cultivation, animal husbandry, improved varieties and unnatural transgenic crops. Those measures and innovations have increased production, but also bring a lot of environmental problems as well. China followed the Westerner but must upgrade its modern agriculture to macro-agriculture. In this 21st century China should take her own economic model to feed her great population. The former Minister of Water Resources, Wang Shucheng said we must adopt C Plan, neither A Plan, which means doing business as usual nor B Plan suggested by Lester Brown in his book “B Plan”. C Plan means the economic development must take into account the carrying capacity of resources and environment in China. China has larger population, less land; larger population, less water; larger population, less oil. In order to realize the strategic objectives of sustainable development we have to register three "zero growth", one after another: zero population growth in 2030, zero growth of energy and resource consumption rate in 2040, and zero growth of eco environmental degradation rate in 2050 [9].

In recent years, as Mr. Chen Xiwen Deputy Chief of Central Rural Work Leading Group explained that under the guidance of the rural policy, agricultural and rural development had kept a relatively good momentum in China and by 2015, China’s grain production had been achieved for 12 consecutive years. The total grain output reached 1242.9 billion Jin (1/2 kg) (621.45 billion tons), an increase of 28.8 billion Jin (14.4 billion kg) over the previous year. It should be expressed that the continuous growth in 12 years neither happened in Chinese history nor in the world history [10]. From ancient time up to the present, an agricultural proverb: “Food in hand, heart at rest.” has been cited by many political leaders. It means if you had grains in your hands, you could set your mind at rest. That is why we have to retrospect our own agricultural history to find the answer to the questions of Lester Brown, and the worries of the world people including the leaders of minor countries, such as recently deceased Fidel Castro of Cuba.

The wisdom of Chinese nationalities made the development of traditional agriculture for thousands of years without failure, and Chinese Nationalities have innovative ability to solve real problems. Here is a story of rice cultivation by the Tao Theory. Please see Case 1, 2 and 3.

At present, most of China's staple food could be expected to be self-sufficient by 80% in 2020, but not soybean and corn. Furthermore, when the average income increases, people need to move upward to the higher end of food chain, eating better and healthier, therefore, we should take a path of developing macro agriculture path in the 21st century as proposed by Xi Jinping in 1990. As I understand, macro agriculture must orient to a multi-functional, open-type, integrated development, stereo-agriculture, which will be different from a small agriculture for self-sufficiency, Macro agriculture is a planned commodity economy facing both domestic and overseas markets to pursue commodity rate of agricultural produce. First of all, we need to change concepts from narrow minded - that grain production was to plant crops of the grass family (rice, wheat and corn) to a great food concept. It will be agro produce commodity concept instead of self-sufficiency and self supporting concept. The integrated development means to promote moderate-scale management, to pay attention to unification of ecological, economic, and social benefits, different from old comprehensive development of agriculture, forestry, animal husbandry, side occupation and fisheries, not

considering their interrelationship only to pursue the economic benefit of one sector [11]. Macro-agriculture should be grasped as a system engineering to gain overall benefits for the mankind because China and other countries are one community with a common destiny.

According to the new requirements, learning from international experience, we take into account the domestic resources and environmental conditions, food supply and demand patterns and international trade changes. The Central Rural Work Conference held in December 2013 put forward the New National Food Security Strategy. In 2014, the Central Number 1 Document states that we have to implement the National Food Security Strategy: "China the mainstay, Foothold in domestic, Capacity secured, Import moderately and Support by Science & Technology. The basic objective is to ensure that the staple food self-sufficient and the rations are absolutely safe in China [12].

Song Hongyuan, the Deputy of Research Institute in Ministry of Agriculture said in order to implement the new national food security strategy, we have to deal with two important relations, between the quantity and quality of food, and between the current food supply and the sustainable development of agriculture. Five key works should be done: Firstly, the red line of cultivated land strictly kept; secondly, the enthusiasm of farmers to produce grains be promoted and the enthusiasm of officials to firmly grasp grains be maintained; thirdly, the responsibility of the central and local governments be clarified to balance grain supply and demand on food; fourthly, agricultural science and technological innovation achievements be promoted and extended; fifthly, the capital input to improve agricultural infrastructure and agro production conditions be increased [13].

5. CRUCIAL FACTORS IN MACRO-AGRICULTURE

China is one of the birthplaces of agriculture in the world. Agriculture is the foundation of Chinese culture, the objective of agriculture is to solve the basic needs of the people and agriculture also determines the lifestyle of the people. Chinese civilization has a long history and labor productivity is the first element. Chinese nationalities bear hardships and hard work, and they have virtues of letting everybody display fully his talent, making the best use of everything, being industrious and thrifty in managing a household. Farmers have accumulated a wealth of experience in long-term agricultural practice. China has summed up a set of integrated farming systems coordinating various sectors of macro-agriculture; the core is to correctly handle the interrelationship between how to use soil nutrients and to maintain soil fertility. In order to solve the problem of food and clothing of the people, we must inherit the fine traditions of the ancient.

5.1 The Following Crucial Factors in Macro-Agriculture Should be Focused

5.1.1 Water resources

China is a country seriously facing shortage of water in the world, having water resources about 2200 m^3 per capita, only a quarter of the world's water resources per capita, with annual water shortage of more than 20 billion cubic meters for agriculture. China put emphasis to build water conservancy facilities in ancient times. They built irrigation canal projects, such as Zheng Canal and Du Jiang Yan project with no bank but diversion water for irrigation. Po Tang Storage engineering, Lake Taihu pond polder system, seawall engineering and the Karez irrigation system in Xinjiang Autonomous Region to utilize water from melting snow from Tian Shan, Altai Mountains, Kunlun Mountains which is leaking into the gravel layers through the foothills to become underground flow. In recent decades, we are building a South-North Water Transfer Project, which is a national strategic project. It aims at alleviating the water shortage in the North and Northwest China. Beijing can get 10-15 billion cubic meters of water in this project. According to Wang Weiluo, 2014, there was no feasibility study report as a solid foundation. He thought that it would destroy the natural balance of the water cycle and might have a negative impact on the ecological environment. He has also criticized Beijing has been the world's most expensive water waste city, with consumption of 300 liters per day, 2.5 times greater than the German consumption rate of 130 cubic meters per person per day.

In fact, to transfer water from the Southern China which is full of water to the Northern China that is short of water is a social progress as it is a man-made balance of water cycle. As for the water consumption in Beijing, the information indicates that in 2014, the resident population of Beijing

was 21.52 million, consuming 1.7 billion cubic meters of water, per capita daily water of 216 L/d and not 300L/d. The population of Beijing is floating by 20% and the total population will be 25.8 million, with per capita daily water consumption of 180 L/d, 38% more than Germany. If the total population reached 30 million in 2030, the per capita water consumption would be 155 L/d, with 20% more than Germany; if the total population reached 35 million in 2030, the per capita water consumption would be 133 L/d, basically the same as in Germany.

Water pollution is the same problem as in the early stage of development in developing country and we have to control the pollution in a long period of time e.g. 5-10 years. The main merit of the project is that Beijing can get 10-15 billion cubic meters of water and thus, can significantly reduce pumping of the underground water. Originally, 1.7 billion cubic meters water was extracted from underground water by 52%. Therefore, it is correct to build the South-to-North Water Diversion Project, but some problems need to be improved further [14].

Another water conservancy project will be water diversion to transfer 130 billion cubic meters of water per year from Tibet to Xinjiang. The largest investment project of the Asian Infrastructure Investment Bank is the comprehensive infrastructure project of China's Tibet and Xinjiang, turning the Taklimakan Desert of the 560,000 square kilometers, Tarim Basin and the Gurbantünggüt Desert of the 180,000 square kilometers, Junggar Basin into oasis, pasture and fertile land, creating 120 million jobs for Xinjiang, so that China's 32 million poor families will get out of poverty, to realize the rise of western China economy [15] [Fig. 5].

5.2 Soil Fertility Renewable Problem

A British agronomist has once said that Chinese farmers have put all the rotten organic matter back to fields. That is the reason why China can support a large rural population and maintain soil fertility renewable [16]. In early 20th century, the United State agronomist, Franklin King, wrote a book "Four Thousand Year Farmers" with a subtitle - Permaculture of China, Korea and Japan, listed what he saw in China about fertilizer: human waste, livestock manure, poultry manure, silkworm feces, vermin-compost, ask, leaves, ask leaves, green manures, compost bone powder, slurry, tarragon stalks, snail shells, soybean cake, stove ash, other miscellaneous manure [17]. People made compost in the past, using stool in household, putting wild grass and litter in animal house in a sump beside rice fields for wet compost, also dredge silt from the bottom of rivers and lakes for fertilizer. In 1920, Taiwanese Luo Guorui invented digesters (now being called China Dome) which expanded all over the country like blossom everywhere. All organic matters ferment through the digester to produce biogas, slurry and sludge which are all fully utilized.

That is the reason why the soil fertility could be renewable. To alternate the demerits of fossil fuel agriculture, we need to use organic fertilizer instead of chemical fertilizers. Organisms in nature are in interdependence and interrelation. Rice and small organisms and microbes co-evolve in harmony. Co-evolution of the biome can nurture the soil. We have to take full advantage of using all the agricultural wastes, turning them into treasure [18].

5.3 Land Resources Problem

According to 2008 data of the National Statistics, the total farm land was limited in China. The total land area was *1,826 million mu* (12.17 million ha) or 2,350 million mu (156.7 million ha) with multiple cropping index, in a good cropping year. In order to supply 7 billion tons of grains or more per year, on the basis of present unit yield 330 kg/mu, we need at least 1600 million mu (106.6 million ha) farm land a year. We deducted 1600 million mu (106.6 million ha) from 2,350 million mu (156.7 million ha), while 750 million mu (50.1 million ha) would be left. Furthermore, 200 million mu (13.3 million ha) was needed for peanuts, sesame and vegetable oils, 80 million mu (5.33 million ha) for cotton, more than 40 million mu (2.66 million ha) for sugar and basically 270-280 million mu (18-18.6 million ha) for vegetables; the remnant for tobacco, hemp, including a variety of flowers, nursery stock, all kinds of Chinese herbal medicines, etc [19]. The land in China has very less leeway for adjustment.

5.4 Provenance Issues of Varieties

China is rich in bio-diversity; there is a wealth of germ-plasma resources, for example, rice as one of the native cereal crops in China for cultural rice relics 7,000 years ago were unearthed in Hemudu Zhejiang Province. Several Great Lakes region of the Yangtze River was the domestication place of wild rice and others,

Ramie *Boehmeria nivea* is a fiber plant with Chinese characteristics. Sumac is also special characteristic of Chinese civilization. "Book of Songs" mentioned mulberry not only more than 20 times, but also left lots of account of mulberry planting. So, China is the earliest country in the world for sericulture, planting mulberry, and reeling silk.

In 6 January, 2015, the Ministry of Agriculture of China declared that potato would gradually become the fourth staple food in China. This is because the protein content in potato is high, and has all the essential amino acids. The vitamin content of potato among all food crops is the most complete, equal to twice the content of carrots; B vitamins are four times more than apples. Potatoes are storage tolerant than wheat, corn and rice. Potato flour can be stored 15-20 years without deterioration. The country hoped that they could have access to genetic resources in new varieties through international cooperation with the equitable sharing of benefits**.** In all soybeans producing countries, the original seeds came from China, but as a country of origin, China has not gained any benefit from the origin source. China also opposes to a number of international companies' 'bio-piracy' and advocate protecting the legitimate rights and interests of developing countries. Developing countries can exchange with each other. China may get tomato (TSWV virus) resistant peanut gene from Brazil to improve peanut varieties; Brazil can get original soy bean rich of soy lecithin from China. On biodiversity, China is adopting an open policy and Chinese aquaculture has maintained a leading position in the world. It is hard to imagine that China spend lots of money like the United States of America to wipe out Asian carps; hence, how much animal protein can the country produce to meet the demand of the people.

5.5 Seed Industry Problem

Seed industry is the foundation of agriculture. More than half of the seed companies in the country are in the hands of foreign capitals, increasingly being dominated by multinational companies, starting from fruits and vegetables, toward grains and oil. Now, the seeds purchased from these seed companies can work just in one season and this phenomenon is very dangerous. The purpose of international Agribusiness Companies engaged in transgenic is to monopolize the seed and maximize profits. Needless to say, GM crops are not safe; especially Glyphosate gene transferred harmful to human being. Therefore, the seed industry must resolutely oppose monopolies as nationalization is the only option. As the "Convention on Biological Diversity" indicates, we have to set up access to genetic resources and benefit-sharing regime, disseminate knowledge of plant varieties, domestication, and breeding animals, and furthermore to disseminate the knowledge on how to use plants, animals and microorganisms as medicines, and the knowledge of biological resources, fermentation and brewing technology.

6. THREE CASES FOR MACRO-AGRICULTURE

6.1 Case No.1 Grain Production in Gansu Autonomous Region

An innovator Mai Yilin has a piece of rice field at Guotan village Dongyuan Town in Zhongwei City, Ningxia Hui Autonomous Region. He inherited Three Essentials Theory and adhered to Three Fittings Principles, created ecology model of rice cultivation by three odd measures taken. First, he transported sands from the Tengger Desert nearby by trucks. He paved the rice fields with a thick layer of sands in line with local conditions. The local soil is compacted clay, hard as a rock. When mixed with sands, the soil becomes loose, and then rice plants grow stout and deep, with root length of 26 cm, up to 40-50 cm long, so that rice plants will not go lodging, whereas the root length in traditional paddy fields is less than 20 cm. Secondly, when rice pests and diseases occur, he did not apply any chemicals (pesticides and fungicide). Before jointing (elongation) stage of rice growth, he did not save rice seedlings invaded by pests or diseases, even let invaded rice seedlings die or let the feeble seedlings die off, increasing the resistance of rice seedlings as to breed strong seedlings. Rice seedlings per hill in paddies have 32 tillers on spot counting. In the environment of Ningxia, rice pests and diseases are mild and they cause less damage, and the damage does not exceed the economic threshold as to force them to use this method. Thirdly, he does not irrigate sufficient water to grow rice plant. Dryness suits rooting; water suits budding. He would like rice plants to exploit their own latent potentiality. The traditional rice cultivating farmers irrigate 20 cm water depth; he adjusted the water depth to 2.5 - 3 cm. In mid-July every year he started to control the water depth, 10 days in advance than local farmers. When farmers control water, they will drain paddies less

than a week while Mai controlled water for up to half a month. In draining fields, the oxygen content in the soil is high, but still there is some moisture for crop to grow, drought may make root system developed with more small roots newborn. The more the nutrients can be stored for rice in late stage, the more there will be a lot of nutrients available for delivery. In addition, he had another two strokes: To strengthen rice resistance and to modulate different nutritional formulations for different rice stages in a decade of exploration, containing nitrogen, phosphorus, potassium, calcium, iron, zinc, amino acids, and various vitamins. Let rice plants dry a while at booting stage, and then spray the nutrient solution, they would absorb more nutrients beneficial to grain filling, to improve the quality of rice. Under the guidance of Agriculture and Animal Husbandry Bureau, Mai Yilin intended to further ameliorate the soil. There was no ridges in any rice field, 50-100 mu each rice paddy (mu = 1/15 ha) which would be leveled by a laser leveling apparatus, and by direct seeding different from transplanting rice seedlings from seedling beds, seeding in wide and narrow rows reciprocal. With good ventilation and light, large space, plenty sunshine, organisms and microorganisms multiply in paddy fields. After the biomass die they would be the best organic fertilizer for crops. If exported, grains would have been checked up by the Quarantine Bureau, at export port such as Tianjin and they did not detect any of eight kinds of pesticide in grains. Thus, the price of grains reached 100 Yuan per kilo [20].

6.2 Case No. 2 New Cultivar Sea Rice 86

It is of great significance in the world that China discovered Sea Rice 86 and this kind of salinity-resistant rice variety is being sought by many countries. Egyptian scientists are doing the hybridization of lagoon reeds and rice; Hybrids of two salt tolerant rice lines are ongoing in the Philippines; Indian scientists are trying to extract salt tolerance gene from mangroves, aiming to put them into the existing rice lines; Japan would like to change the properties of rice by using light waves of information mixture. However, Chinese researchers have also done a hybrid between cord grass *Spartina anglica* in coastal beach and rice cultivar, by using transgenic technology and other methods, but in vain. These have placed the country high to say that “there is no place in the world except China in finding saltwater-resistant rice [21].

Sea rice was found by Chen Risheng on the Tiger Head beach of Suixi County, Zhanjiang City, Guangdong Province in 1986. He began the breeding work in 1987 and expanded the planting area of Sea Rice 86 to 2000 mu (133 ha) in 28 years by trial and error and finally the wild sea rice plant was being identified as a specific cultivar. In April 2014, the Ministry of Agriculture accepted the right application for a new cultivar of Sea Rice 86. September 1, 2014, Sea Rice 86 was published in the "Agricultural Plant Variety Protection Gazette" and was included in the rice hybridization test Inspection program of Ministry of Agriculture.

6.2.1 It has the following superior qualities

- Sea rice tolerate saline-alkali soil and can be planted in coastal areas and inland saline-alkali soil no matter where it is, north or south and even it can grow on saline soil of pH 9.3 and where trees cannot grow. Thus, many mud flats in coastal areas could be changed to be farm land. Inland salt saline land can be ameliorated by sea rice within 3-6 years based on his practice. China has a total of 100 million hectares of saline-alkali land, equivalent to increase 100 million hectares of arable land, even if only part of the land can be planted with sea rice, it is significant for China with large population but limited arable land to produce rice (Figs. 1, 2, 3 and 4).
- Sea rice is a plant tolerant of water-logging. If sea rice is submerged for 3-4 hours it has the ability of surviving the condition. Sea rice even grows flourishing after inundated with seawater than before the high tide. Furthermore, producing 1 ton of rice grains roughly needs to irrigate 1000 Cubic meters of fresh water. This special quality of sea rice cultivar would give opportunity to countries with water shortage to grow the crop at ease.
- Sea Rice needs not to be fertilized because seawater offshore contains enough nutrients and is a prominent advantage. Since the late 1970s, the farmland fertility in China decline sharply with average organic matter in soil less than 1% while fertilizer use soared up. The safety limit of fertilizer internationally recognized is 15 kg/mu (225 kg/ha), but the current average fertilizer application rate is 29 kg/mu (434.3 kg/ha), 1.93 times than the safe limit [22]. In the 1950s, 1 kg

of fertilizer can increase 25 kg of grains; up to 2005 when one kilogram of fertilizer only increases10 kg of grains, with its effectiveness to be reduced by 50% to 60% in 30 years [23]. Long-term use of these fertilizers makes the soil saline and lead to desertification.

- Sea rice having anti-pest-specific genes (pest-resistance) can reduce the use of chemicals to prevent soil from contamination by chemical residues and heavy metals. These genes can also be used to improve the properties of other crops, thereby increasing its production. It will further increase grain production in China, without the need to import. This will solve the problem of food security in China and the world's food security as well.

Fig. 1. Chen risheng is observing the growth of sea-rice, submerging himself in rice fields

Fig. 2. Rice plants flourisging grown after low tide in saline-alkali soil at the Tigerhead sloping fields Suixi

In summary, China with the new rice cultivar, Sea Rice 86, has solved the problems of the world crux of rice cultivation. China is not only able to feed ourselves, but also to help other food-deficit countries in the world to feed hungry people. As a back-up in agriculture, the surface water of small lakes and streams can be utilized to grow rice by surface aquaponics technology if needed as Song Xiangfu et al. [24] wrote in their papers. In January 2014, a United Nations report noted that global grain stocks fell for 30 years and this gave rise to 800 million hungry people worldwide. If about 0.95 or 1 billion hectares saline-alkali land worldwide (14.3 billion mu) could be utilized to plant sea rice 86 in seawater, it would be the gospel for the world people [25].

Fig 3. Rice Submerged by high tide at saline-alkali soil of the Tigerhead sloping fields in Suixi

Fig. 4. Rice grains of sea-rice grown by seawater

In 20th Nov. 2016, on spot of Huangpo Village, Longtian Town, Xingning, Meizhou Guangdong Province the check group announced that the unit yield of Southern China Double-Season Super Rice reached 1537.78 kg/mu, which is a new world record. The Academician, Luo Xiwen,

said the yield of double season super rice is equal to the yield of three seasons, so it is a breakthrough in rice production [26]. Chen Risheng said that he was encouraged by the success of Professor Yuan's hybrid rice. He added that, over the years, he has had an idea to produce a water logging tolerant and salinity tolerant rice variety. Pest and disease resistant genes will help Longping special hybrid rice to increase yields. Both sea rice and super rice are two breakthroughs in China from wild rice. Professor Yuan said, "If there is no wild rice resources, there will be no good stocks and there will be no breakthrough in rice breeding." So, we have to protect biodiversity. "Chen Risheng believes that Tiger Head slope Suixi County should be designated as the origin of Sea Rice and became the National Wild Rice Natural reserves and the National Geographical Mark and the rice germ-plasma should be protected forever. Chen's dream is to turn the wasteland surrounding oceans into thousands hectares of sea rice paddies with blossoms and grains.

Academician Yuan Longping and Chen Risheng would cooperate to commercialize Sea Rice 86 in Qingdao Shandong China. They are planning to develop Sea Rice with unit yield of 300 kg/mu (4500kg/ha) in three years. China has 100,000 ha of saline alkali soil, among which 13333 ha have the potential to be planted Sea Rice. If the planting succeeded, China could increase 50 million kg of grains on the basis of 200-300 kg per mu (3000-4500 kg/ha) and this can feed about 200, 000,000 people more [27].

6.3 Case No 3 Planting Rice in Arable Desert

When Teng Fei came to Naiman Banner, Inner Mongolia in 2013 and caught a scene of scattered rice paddies in front of the houses, which aroused his interest, he decided to grow rice in desert and invited his sworn brother, Li Shaohua, to join the establishment of Xin Zhong Nong Company, devoting himself whole-heartedly in planting rice in desert. Both are the pioneers of rice cultivation in desert on a large scale [28].

According to three essentials (Heaven, Earth and Human) theory, they surveyed the geography and climate in Naiman Banner, which is located in the South-western margin of Khorchin Desert. During spring the desert is plagued by aggravating wind and sand erosion. However, there are geographic advantages: soil humidity indicating plenty of water underground; no soil, water and air pollution for any large-scale chemical industrial enterprise in the diameter of 170 km. There is a big gap of diurnal temperature difference in climate, hot in day, rice growing quicker; cold in night, nutrients and trace elements precipitating speedily in grains. The accumulated temperature can reach up to 3200 degrees, i.e. the accumulation of diurnal temperature difference during the growth period, which is a very important factor. Naiman Banner also has a 160 day frost-free season, which provides rice nearly a half year growing period, enabling them to grow fully and make the precipitation of nutrients more homogeneous. The unique natural conditions can turn the desert into a fertile farmland.

6.3.1 On the above they adopted the following innovative measures

6.3.1.1 Wind

They resist against sandstorm with wind-proof bush barriers, which is the crystallization of local wit that goes down for centuries. Squares are formed one after another setting up several natural barriers. Thus, they efficiently resist against the attack of wind and sandstorm. When the wind blows, every square abates the force of wind. Finally the wind gets gentle to some extent and mitigates the harm brought by sand on rice paddies.

In recent years the state expended large amount of manpower, material and fund in forestation projects, but sand still marches while human retreats. When rice has been planted in this desert, there is no sandstorm, with good ecological effects. They also invented a new speedy tree planting technique based on water drilling method, which forces water into the ground with high pressure to plant trees. The seedling they planted would grow into trees with a diameter of 2 meter of canopy in the following year. This will promote windbreak forestation in northern China.

6.3.1.2 Water

There are two kinds of deserts: arable and non-arable desert. The arable desert means sandy soil rich in underground water and organic matter while the non-arable refers to the desert without any underground water.

(1) The company adopted mulch film technique, which was the local wit too. Mulch film was buried 15 cm underground in the past, but they dug the rice paddy like a fish pond to 0.8 m below and laid mulch film at the bottom to avoid water seepage and then recovered sand in a thick layer, conducive to the growth of root system of crops. They also improved a prescription of film to reduce its oxidation, the rate of damage, and the new one extends its use up to 50 years.
(2) They extracted underground water from 70 m deep and power grid set up to support 30-40 pumps buried 20 m deep under the ground. There is an eight-directed outlet valve as mouths to adjust water flow to 60% -80% of a paddy from late May to early September if there is no rainfall.
(3) The flatness of soil is crucial to most crops, especially rice. Bumpy sand dunes will increase the consumption of water and should be leveled by a laser leveling equipment to keep the flatness within 2-3 cm error to save more water.

6.3.1.3 Weed and pests

They pulled weeds at first by manpower instead of using herbicides which is very laborious. The team had developed a special cover not only to reduce evaporation, but also to extinguish weed growth. Besides, it can raise the temperature of water from underground. If any rice plant pest occurs, they drain the water in paddies and all the pests will die in 2 hours by sun burn without applying any pesticide.

6.3.1.4 Manure

At the beginning, they bought cow dung from farmers and applied farmyard manure to the rice paddies. Later, they set up a pig farm near the base to integrate rice planting with pig breeding. Rice straws became favorite food for the sows. The pig manure full of organic nutrients was then applied to the paddies to promote the propagation of microorganisms in soil and turn sandy soil to black land. As a result sandy soil turns to be ameliorated soil in micro-environment.

6.3.1.5 Scale

Rice planting in desert on a large scale must depend on modern agricultural machinery such as rice seedling transplanting and harvesting machines to reduce labor cost.

6.3.1.6 Seed

They must adopt excellent cultivar with better lodging resistant capability which can stand the strong wind and survive in a severe environment. They tend to select high-yielding variety such as Wuchang Rice Flower No.2. The practice of Ertun Bilige indicated the unit increase in rice yield of Rice Flower No.2 up to 500 kg/mu [29].

6.3.1.7 Economic Model

Teng Fei developed an economic model of “Enterprise + Cooperative + Villagers”; during planting process the company organizes one cooperative each of 1000 mu paddies for 10 households, providing them with technical and mechanic supports such as transplanting and harvesting machines. The famers of 10 families join transplanting rice seedlings in May and harvested the rice in October and gained 50,000 Yuan income in five months. This has brought a radical change for local poor farmers to get rid of poverty.

6.3.1.8 Circulation

They sell rice grown in desert on Internet to reduce cost for circulation of the commodity and give benefit to consumers and guarantee the rice quality. The popular raising fund and sightseeing agriculture may further save the cost, to bring more benefits to consumers.

6.3.1.9 Original intentions

Teng Fei‘s first original intention is to turn desert into farmland with Xin Zhong Nong Company planting 15000 mu (1000 ha) rice paddies in the desert in 2016. In Kulan Banner Southern Khorchin Desert, 25000 mu (1667 ha) rice paddies were cultivated by 2500 households of 28 villages in 2016 [30]. China only has 1,800 million mu (1200 million ha) farmland to produce grains for a large population which run short of the area required. Open data shows there are more than 300 million mu arable deserts in China that can be converted to arable lands. If all arable sandy soil turned into farmland, it would be of great significance. Teng Fei thinks “we do not have the ability to accomplish the development of 300 million mu of arable desert, but as long as our products can successfully be brought onto the market, arable deserts will become hot places in China”. “At that time we will not stand alone, we hope that our success will lead more people of insight quickly to get into this domain so that China's desert would turn into fertile land.” Now deserts are turning into oases”.

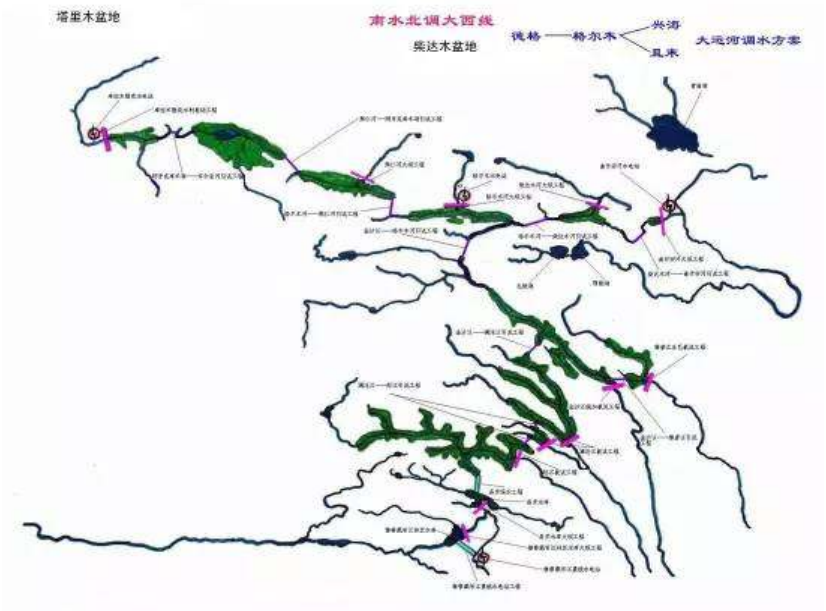

Fig. 5. Water diversion project from Tibet to Xinjiang

His second intention: let common people eat real safe organic rice on average (below 10 Yuan/0.5 kg) cost. In processing grains they do not remove plumule, thereby reserving the nutrients in grains, hence, giving the rice better flavor and taste. Xin Zhong Nong Company opened all their planting techniques at the end of 2016, cooperate with those interested people from Inner Mongolia, Xinjiang, Ningxia and Gansu or other places to develop rice cultivation in arable deserts.

They not only cultivate rice, but also veggies such as celery, cabbages, turnip, and asparagus; and even set up sightseeing plantations such as grape, melon and herbs gardens in desert. It boosts local economy, and improves the environment in desert as well. You can see groups of birds in days and listen to the call of frogs, a symbol of ecological restoration. Desert-to-oasis would achieve many things at one stroke [31].

7. CONCLUSION

Three questions raised by Lester brown were based on his assumption that China cannot feed herself. But that was contrary to the historical facts. The papers retrospect the agriculture from the ancient China to the modern China, compared the traditional agriculture with the petro-agriculture, and examine the key factors of macro-agriculture. From the agricultural theory to the production practice of the people, from the officials to the laymen, from the characteristics to the wisdom of the mass, from the state policies to the National Food Security Strategy, the conclusion is definitely that China can not only feed herself, but also would contribute to the world by their innovation in macro-agriculture. Therefore, anyone should not underestimate the creativity of the Chinese people as we can feed ourselves.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Lester Brown. Breaking New Ground. W.W. Norton & Company; 2013.
2. Lester Brown 2011. Can American feed China, translated by Li Kangmin 2011-03-23 the Journal of “World Environment. Available:www.earth-policy.org/plan_b_updates/2011/update93
3. Michael T. Klare. The race for what’s left – the global scramble for the world’s last resources. Metropolitan Books 2012, The Race for What’s Left simplified Chinese translation copyright 2014 by Shanghai Scientific & Technological Education Publishing House. 2014;2015.
4. From [Lv’s Annals] to ["Qi-Min-Yao-Shu” (Key Arts for Qi People) (420-581)] Source <Zhejiang On Line 2009-09-17

5. Agricultural concept in Ancient China.
Available:http://zhidao.baidu.com/question/2625316.html?si=1
6. Zhou Enlai. Government Work Report; 1954.
7. 2008-08-04 Xinhua News Network: Chinese "Reform and opening" achieved three great turning points.
8. The data published by the State Statistics Bureau in China as of 31 Dec 2012.
9. Outlook Newsweek 1999(12)10-12 Chinese Sustainable Strategy Report of CAS.
10. News from Information Office of State Council; 2016.
Available:http://www.aweb.com.cn
11. Xi Jinping. To take a path of macro-agriculture Fujian People Publishing; 1990-04.
12. No1 Document on Agriculture in 2014.
13. Interview with Song Hongyuan by Wang Hongru, correspondent of China Economy Weekly; 2016.
14. Wang Vero. Divert Water from the South to the North - A River of Sewage Flows Northward; 2014.
15. The largest investment project of the Asian Infrastructure Investment Bank.
16. Li Kangmin. Developing Ecological Agriculture in 21st Century China. J. Asian Farm Systems Association. 1991;191-200.
17. Franklin H. King, farmers of forty centuries - on permanent agriculture in China, Korea and Japan Chinese copyright by Orient Publishing House; 2011.
18. Gansu Farmers. paper, 2014-09-04, Microbial fertilizer will lead the development of the fertilizer industry in a new direction. Author unknown, Edited by Yang Yang.
19. Chen Xiwen's speech in Nanjing Agro University in 2010 from Central Rural Work Leading Group Office of the State Council.
20. "Science & Tech Garden"2015-01-14 Some Odd Measures to Produce Good Rice.
21. Zhanjiang Daily.
Available:http://paper.gdzjdaily.com.cn/html/2014-10/23/content_5_1.htm\
22. Legal Daily. 2011-05-27 News report, the title is. The amazing amount of Chemical fertilizer in China.
23. Gansu Farmers paper, 2014-09-04. Microbial fertilizer will lead the development of the fertilizer industry in a new direction. Author unknown, Edited by Yang Yang.
24. Song Xiangfu, Ying Huodong, Wu Weiming, Jin Qianyu, Zou Guoyan, Zhu Quilin, Zhu Ming, Li Kangmin, Li Peizhen. Study of surface aquaponics in unison with aquaculture. Aquaponics Journal. 2000;21-25.
25 FAO and UNESCO Soil Map of the world, various saline soils occupy 950 million hectares of ... about 10 million hectares of land are abandoned, mainly due to secondary... scarcity in many areas of arid and semi-arid northwest China characterized ... of growing plants on saline/alkaline soils with saline or brackish water.
Available:www.fao.org/soils-port... 2013-12-20
(total 300.5 million ha salt affected soils in 17 countries and 3 areas in FAO soils portal: soil assessment: Table 1. Estimates of the areas of salt-affected soils in 1985).
26 Chinese super hybrid rice yield of 1500 kg/mu another world record 2016-11-20 Source: [25] China News Agency.
27 Qingdao News Network 2016-12-17.
28 Cong Guanyue 2016. Rice Cultivation In Desert Source: CCTV4 'Across China' Program 20161109.
29 Compass: They grew rice in desert source: Souhu Platform 2015-10-1.
30 Introduction to the Father of Rice in Desert Ertun Bilige Tongliao Daily News.
31 Liu Xiangmei, Rice Cultivation in Desert Realized Double Win in Green and Wealth, Tongliao Daily News 2016-11-07.

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