Ruilin Wang
Shijiazhuang Foreign Language School
Shijiazhuang, Hebei, China
India, Rice Yield

India: Research on the problems and solutions of rice yield

Chapter 1. Background Introduction

Employing more than 50% of the population and accounting for 17%-18% of India's GDP in 2018 [1], agriculture serves as India's biggest pillar industry. Among all the agricultural products, rice is the most valuable, with a total output value of 70.18 billion dollars in 2016 and 44 million hectares of paddy fields. India is the second largest rice growing country in the world as well as the world's largest rice exporter. India produced 106 million tons of rice in 2016, which accounted for 20.2% of global production [2]. United States Department of Agriculture (USDA) even estimated the total production as 150 million tons for 2018-19 [3]. Vast planting acreage and considerable amount of production bring India foreign exchange of more than $3.78 billion per year.

However, even now, 70% of India's farmer are not able to make ends meet. Indian rice yields per hectare still remains relatively low, which inevitably causes poverty among rice farmers. Ranking second globally in rice production though, India has been suffering from low rice yield per hectare for quite a long period of time. The world average yield of rice per hectare is 4.25 metric tons, while the yield varies from country to country. The highest yield per hectare reached an average of 9.82 tons in Australia. India, however, only produced 3.85 tons per hectare.

This article analyzes the issue of Indian rice yield based on India's historical convention, natural conditions, farmers' scientific and cultural qualities and irrigation technology. In view of the above problems, this article tries to explore the feasibility of increasing the yield of rice in India from the aspects of improving farmers' education level, extensively applying three advanced irrigation technologies, further improving the land system and introducing improved variety of sea-rice.

Chapter 2. Analysis of Low Rice Yield

2.1 Low Scientific and Cultural Quality of Farmers

With the continuous progress of science and technology, advanced planting techniques, which are crucially important in increasing rice yield, are springing up at great speed. However, to master these techniques, farmers must first have knowledge about fertilizers, improved seeds, pesticides, modern farm tools, soil and operation of new machines. Therefore, in order to make a quantitative leap in rice yield, Indian farmers need to become "smart" first, which requires an effort to popularize and improve farmers' education.

Literacy is the fundamental premise of learning and applying new farming techniques. Although many education organizations use visual aids and verbal instruction to teach, if farmers are unable to immediately digest what is taught on the spot, they can't review the knowledge using reference books in private. When farmers want to look up specific information, illiteracy forces them to ask for verbal help, which is far more inefficient and inconvenient. Illiterate farmers are forced to plant in traditional ways without innovating. This partly leads to the low annual growth rate of yields. A research in 1990 estimated that at the present rate of development, India would not achieve universal literacy until 2060. According to the census of 2020, India have a literacy rate of 81.3%, which means near 1/5 of their people there couldn't even write their own names [4]. Although the government has taken measures to deal with this issue, India's growth on literacy is still regarded as "very slow".

To become a "smart farmer", being literate is insufficient. The ultimate goal is to master advanced techniques through learning. India is currently promoting agricultural education in rural areas by setting up schools in the State of Karnataka [5] to teach relevant planting and marketing methods. However, there still remains quite a lot of problems, such as the lack of equipment and venues, the poorly scheduled class contents and disparity between states. In some areas, the timing is unreasonable. Farmers have to receive off the job training for a long time. Moreover, lack of practice makes knowledge easily forgotten. Unable to transfer their hard-learned knowledge into an increase in production and economic income, farmers feel less motivated to carry on their education. What's worse, due to the poor conditions of rural areas and the low income, people with high agricultural qualifications seldom choose to be teachers in peasants' school. Some knowledge are too professional for farmers to understand, while many teachers at farming school aren't able to teach them in a pellucid way.

2.2 Historic Limitations

2.2.1 Limitations of Land Reform

Indian land policies have left the average Indian household with very little and fragmented land possession, which has a serious impact on the efficiency of land use, leading to over cultivation and low productivity.

Before the first land reform, India had been implementing a land policy know as "intermediary landlord system", which was a land tax system introduced by the British East India Company for the purpose of colonizing India. Those intermediary landlords (known as "Zamindar" in Hindi), were mainly tax collectors during the Mughal Empire, had no ownership of land at that time. In 1793, the Company implemented a new law in Birla Orrisa, Bangladesh, abolishing rural communes' hereditary ownership of land and recognizing Zamindar as the landowners. Zamindar were to pay 9/10 of tax from that year on. [6]

After India's independence in 1947, the Nehru government made agriculture the first priority of the nation. During the ten years' period from 1950 to 1960, a land reform legislation to abolish intermediary landowners was enacted. One of the law's purpose is to improve the production rate of agriculture and to solve the food crisis. According to the law, the state was to purchase land from Zamindar, while tenants paid land price to the state so as to get the ownership of land. Though the first reform eliminated the biggest landlord in India, it didn't overthrow the feudal land system. The dominating group is still Zamindar, who had received a total of 6.7 billion rupees from government compensation and continue to possess their own private land (which was also the most fertile). A small number of peasants became rich by purchasing and possessing a large amount of land, whereas most tenants still remained poor for they couldn't afford to pay the land prices. As a result, many tenants had to work as farmhands in order to pay their debts.

At the end of 1961, the Indian Government introduced the "Land Holding Cap Act", which stipulated that surplus land should be collected and given to landless farmers or agricultural cooperatives by the state. Nevertheless, due to the excessive flexibility of the limits on land area (22-336 acres in Rajasthan) and even cap exemption (up to 20 types of land in Uttar Pradesh were free from limits), so there was little land left for redistribution by 1972.

Although India's land reforms have achieved a lot in redistributing the land and protecting peasants' interests, they failed to meet the ultimate goal of increasing productivity rapidly and revitalizing the business of agriculture. Large gaps remained between the reform measures and reality. Some measures were not implemented as they should. Before the land reform, Zamindar were most rising bourgeoisie. Most of them lived in cities and leased their land to tenants and didn't manage the land themselves, only making a living by exploiting their tenants (the rent Zamindar taken from the tenants are 23 times of which they handed to the state). Therefore, most of the funds belonged to those who didn't care about agricultural yield, while those who cared didn't have adequate economic supports to improve their planting methods. Thus, agriculture yield (including rice) remained low during this period.

2.2.2 Influence of Caste System

India's 157 million hectare's land are divided into 146 portions. Highly fragmented land distribution has been cited as an important reason for the low yield of India's agricultural products, including rice. One of the key reasons for this is the suppression brought by the caste system. The so-called "Dalits", or precaste, own less than 9% of the vast cultivation land. Most of them are landless up till now. The landowning Dalits also face daunting challenge, the land they own simply could not support the large population. Nearly 61% of the land owned by the untouchable is less than 2 hectares per person, which are generally described as marginal land (less than 1 hectare) and small land (between 1 and 2 hectares). Medium-sized farmers with 2-10 hectares make up only 1/3 of the untouchable class of farmers. This shows that the aftermath of the caste system has not been completely eradicated in India.

2.2.3 The Drawbacks of Green Revolution

The Green Revolution in India refers to the period when Indian regarded achieving agricultural industrialization by using modern technology and equipment (such as high-yielding variety seeds HYV, tractors, irrigation facilities, pesticides and fertilizers) as its primary goal. The revolution was part of the global Green Revolution initiated by the extraordinary agricultural scientist in the

US, Norman Borlaug, which aimed to use technology to increase agricultural productivity in developing countries. Under the leadership of Lal Bahadur Shastri (who was the leader of the Congress Party at that time), India began the Green Revolution in 1965. [7]

The Green Revolution strongly promoted the increase of rice yields in India, whereas the limitations of it which failed to guarantee farmers' income standard can hardly be ignored. Therefore, the backward situation of rice cultivation wasn't changed fundamentally. HYV seeds, advanced irrigation systems and pesticides are too expensive for most Indian farmers to afford. The high cost of planting forces farmers to take out loans with high interest rates. Excessive borrowing often leads to a cycle of debt, which even affected farmers' basic livelihoods. India's increasing suicide rate of farmers is one of the serious side effects. Moreover, India's liberalization in economy has led to foreigners owing much of the land.

2.3 Constraints of Science and Technology

2.3.1 Constraints of Irrigation

Uneven distribution of water source and inefficient irrigation have exacerbated India's water crisis. In 2013-14, only 36.7% of India's farmland was irrigated. Irrigation in rural areas is especially inadequate. A large amount of farmers there even rely on rain to water their rice.

Rice is a water-intensive crop that has long supported India's huge population. As India's population density increases year by year, the demand for rice steadily increases, which requires more efficient techniques in rice irrigation.

Despite the great irrigation demand, most Indian farmers still stick to traditional irrigation techniques such as flooding or canal irrigation, causing a loss of nearly half of the water used as well as an excessive pollution of the river by pesticides and herbicides (in fact this is what happens in India at present).

2.3.2 Constraints of Backward Fertilizer Technology

India's fertilizer industry is quite undeveloped. As a result, Indian rice productivity rank relatively low around the globe. According to a report by FAO in 2017, the anemia rate of Indian women within childbearing age (15-49) is 51.4%. The malnutrition rate of Indian children under 5 years old is 21% and the rate of poor physical development is 38.4%. [8]

2.3.3 The Threat of Land Salinization

There are 700 hectares of saline-alkali land in India, accounting for 0.7% of the world's saline-alkani land and ranking 6 in the world. [9] Soil salinization has become quite a threat for rice production in southern India, where the weather is often dry. Water underground rise to the soil surface and evaporates into the air, leaving the salt separating out into the soil. The climate in southern India appears to be semi-arid most of the year, leading to a sparse amount of rainfall which joins high tropical temperature in contributing to excessive evaporation and eventually soil salinization. Salinization can reduce upto 50% of the rice yield, causing many regions in the south to give up cultivation.

Chapter 3. Solutions

3.1 Ways to Improve Farmer Education

3.1.1 Government Support

Throughout the world, the government gives preference to farmers' education in terms of funds, policies etc. The US government allocated a large amount of funds to promote farmers' education at a growth rate of around 8% per year from 1955. In 2002, the US government enacted a new agricultural law, providing an increase in agricultural subsides of $51.9 billion in the 6 years from 2002 to 2007, reaching $118.5 billion in total. In Egypt, the national education fund accounts for 5% of national income. Egypt government allocates 330,000 Egyptian pounds to qualified agricultural education agencies and colleges every single year [10]. India government has also paid attention to farmers' education since its independence, but its effort hasn't stood out among those big countries. Indian government allocated 283 million rupees to agriculture in the budget of 2020-21, which accounts for 1.3% of GDP ($2.85 trillion) of 2019-20. India has decided to put more emphasis on agriculture from 2020, aiming at doubling farmers' income by 2022. However, the relevant policies adopted by government mainly focus on the liberalization and internalization of agricultural market as well as farmers' credit and less about the development of farmers' education. In order to invigorate agricultural production, it is essential and basic to improve peasants' level of science and technology. The government of India should pay more attention to establishing agricultural (including rice planting) schools and employing agricultural elites as tutors, offering them preferential policies and generous salaries. For example, they can set up computer labs based on one village, small agricultural schools based on several villages as well as large agricultural schools based on cities. They can also set up agricultural education in normal schools to train excellent teachers for the schools mentioned above. Rural farmers can attend agricultural courses during the stack season of rice planting at schools or regularly watch educational videos recorded by experts at home or at the computer labs in their villages.Balancing development of agricultural education in various states should also be taken into consideration. States owning advanced technology, experience and funds could support and cooperate with weaker states (for example Maharashtra helping Assam) to achieve a win-win result (the emerging form of video conferencing makes this kind of communication and cooperation more convenient). To solve the problem of funds, government can encourage enterprises to invest in government agricultural education programs and give the invested enterprises preferential policies they need as a reward. Donations for the sake of setting up agricultural schools can also be held among citizens. To encourage the government to more proactively execute relevant solutions, citizens can send mails to the government website or the private websites of members of the house of parliament. They can also speak to their local grass-roots officials.

3.1.2 Specific measures

Focusing on smaller perspectives, tutors should teach in a more pellucid way rather than directly infusing professional knowledge which are difficult for farmers to absorb and internalize. Also, to popularize agricultural education, each village could adapt various ways of publicity (e.g. leaflets, board newspapers, CDs, libraries...). Cooperating with qualified agencies to help peasants take part in degree courses is also a good idea. After all, the more intelligent farmers are, the higher agricultural productivity they can produce.

When it comes to high-theoretical techniques, an efficient way is to gather key peasants like demonstration households, young farmers and village cadres for centralized training. Those people can then teach the knowledge they learned to other peasants around them. The government can also launch a project in cooperation with agricultural universities to recruit students each year, sending them to rural areas to equip local farmers with advanced planting techniques.

3.1.3 Practice

Practice is a powerful means to ensure learning effects. In British agricultural education system, the ratio of practice and theory education is at least 2:3, showing the importance of practice. Campus farms and production workshops, at the basis, should be built with the support of government. Offering farmer students with internships to rice enterprises is also an effective way in peasants' education.

3.1.4 Supervision Mechanism

Establishing operational supervision mechanism is also quite important. In many developed countries, to be qualified to work as professional farmers, students have to first pass an examination. German farmers aren't allowed to get preferential policies and loans offered by government before they get "Green Certificate", a qualification for professional farmers. To ensure the quality of farmers' education, qualification examinations are widespread among developed countries. [10] Most countries holds an elimination rate of 1%-2%. Hungary possesses a particularly strict accreditation system, with some schools failing 20%-50% students. Assessment and examination are the internal driving force for the smooth progress of peasants' education. After the Indian farmers receive education, written and operational exams are indispensable. Each state should set up an assessment outline according to the actual situation and in this way, gradually form a sound assessment system.

3.2 Ways to Reform Land System

First, nationalizing and then redistributing a portion of land can be experimented to ease the conflict between landlords and peasants. With the subsides allocated by governments and voluntary investment by villagers, collective production by township enterprises (especially in untouchable areas) can facilitate consolidation of scattered land and therefore improve rice yield. By giving out dividends, villagers' production can increase. Farmers could also be encouraged to lease their land to professionals. In this way, paddy fields can be collected and then cultivated with higher technology standards. Next, government should encourage enterprises as cooperative partners so as to promote diversified development of rice production. [11] Enterprises can try contract operations among small or marginal farmers. Meanwhile, physical infrastructure should be constructed to attract business investment in rural areas. But before labour force in primary industry drops to a relatively low level, the direct participation of cooperative enterprises in rice production should be controlled.

3.3 Ways to Improve Agricultural Technology

3.3.1 Irrigation Technology

(1) Controlled Irrigation

Positive Effects of Controlled Irrigation

Proper irrigation techniques can be used to increase the efficiency of farm inputs and at the same time help the plant grow healthier. “Controlled Irrigation” is a irrigation method operated through testing irrigation conditions such as soil environment and water demand. “Controlled” means “irrigation carried out accurately according to crops’ demand”. Controlled irrigation is able to reduce water used in rice production by 16-35% as well as increase the efficiency of the plants in using soil nutrients and applied fertilizers. [12] Considered to be a technology with high technical content and remarkable effect in improving rice yield, Controlled irrigation is attracting rising attention around the globe. From the following two tables, we’re able to see the positive effect of control irrigation on rice production. [13]

Note: Shallow irrigation’s “Shallow” here means the depth of water is shallow. This method requires irrigating once every 3-5 days to a depth of less than 10mm to just keep the soil wet. Shallow&Wet irrigation is a kind of irrigation method combining shallow irrigation and wet irrigation which dries field at proper times. It requires irrigating up to 30-50mm each time and not watering again until the field is completely dry. Intermittent irrigation means not irrigating continuously. Instead, water every 4-6 days to 30-50mm.

Fig I. Rice yield per unit under 6 kinds of irrigation methods

Number	Species	Experiment I	Experiment II	Experiment III	Average Yield Per Unit
1	Controlled Irrigation	443.905	476.038	509.565	476.503
2	Shallow Irrigation	488.117	455.442	413.088	452.215
3	Shallow&Wet Irrigation	423.618	454.822	466.824	448.421
4	Intermittent Irrigation	437.013	447.854	463.417	449.428
5	Traditional Irrigation	443.905	472.554	345.104	420.521
6	Film Hole Irrigation	484.850	392.011	493.073	456.644

Fig II. Main components of rice crops grew under the six varieties of irrigation methods

Number	Species	Height (cm)	Tillering Number Per Plant	Weight Per Plant(kg)	Thousand Kernel Weight (TKW)(kg)	Spike Number Per Unit	Grain Number Per Ear	Ear Length (cm)
1	Controlled Irrigation	83.2	2.22	6.625	25.643	24.37	95.11	16.63
2	Shallow Irrigation	81.25	2.45	7.252	26.201	21.43	102.70	16.52
3	Shallow&Wet Irrigation	79.65	2.25	6.579	26.401	24.66	93.94	16.34
4	Intermittent Irrigation	82.17	2.24	6.849	25.695	23.19	105.92	16.86
5	Traditional Irrigation	80.26	1.9	5.892	27.057	22.16	94.96	15.96
6	Film Hole Irrigation	79.5	2.32	6.966	27.733	23.63	95.96	16.38

The table above shows the influence of different irrigation techniques on the main components and corresponding amount of rice yield (the theoretical output is equal to the product of the first three items). As can be seen from above, controlled irrigation possesses the highest theoretical yield among the six methods, which indicates that this way of irrigation is the most conductive to improving production, followed by film hole irrigation.

Notes on Controlled Irrigation

Make the field smooth first in order to facilitate irrigation. Then, pour in a relatively small amount of water and rake the field smooth. Fertilizers and herbicides should be applied at last.

It takes about 6-8 days for rice to turn green. During this period, the upper limit of water level is 25-30mm. After transplanting rice seedlings, their roots haven't recovered from injury caused by transition and thus have a weak ability of absorbing nutrition. Therefore, it's important to guarantee water supply.

Field drying should be conducted from the beginning of tilling. In the early stage of tilling, each unit should get 10-15m^3 water for each irrigation. When the rice enters into reproductive period, the lower limit value of water content should be brought down to avoid it tilling too much. The photosynthesis and metabolism is strong at the period of heading and flowering. During this time, the rice needs more water and it is also important to maintain a balance between H_2O and O_2 for the sake of protecting roots. At this stage, water should be irrigated to saturation. The lowest limit is 70%-80% of the upper. This period normally lasts for 10-15 days of irrigation and then comes 3-5 days of field drying. As for expensive irrigation equipment needless to be fixed to the ground, a certain amount of money can be collected to purchase public-used equipment from each household willing to use those facilities. The government should strengthen the road traffic construction and the capability of transportation of the transport lines to rural areas so as to ensure the logistics of equipment delivery.

If water management is neglected during the filling period, rice field will be likely be significantly reduced, for the carbohydrates on rice leaves accounts for 60%-80% of the total. Irrigation is needed every 3-4 days during this stage. [13]

(2) Film Hole Irrigation

Film hole irrigation is a new surface irrigation method developed on the basis of the cultivation technology of film cover. Films are spread on the furrows so as to carry and infiltrate water through the irrigation holes.

The production efficiency of traditional irrigation is 0.40kg/m^3 , which is only 45% of film hole's efficiency. Accordingly, film hole irrigation can greatly improve the production efficiency as well as save precious water.

Fig Ⅲ. Water-use efficiency of the six varieties of irrigation methods

Number	Name	Amount of Water (m^3/unit)	Yield per Unit (kg/unit)	Production Efficiency of Water (kg/m^3)	Water Saved (m^3/unit)	Saving Rate (%)
1	Controlled Irrigation	626.5	476.503	0.76	414.2	40
2	Shallow Irrigation	607.6	452.216	0.74	433.1	42
3	Shallow&Wet Irrigation	674.2	448.421	0.67	366.5	35
4	Intermittent Irrigation	643.4	449.428	0.70	397.3	38
5	Traditional Irrigation	1040.7	420.521	0.40		
6	Film Hole Irrigation	520.5	456.645	0.88	520.2	50

India belongs to the tropical monsoon climate zone, having distinct wet and dry seasons. During the period when there's hardly any rainfall, the high temperature and little precipitation result in high evaporation, posing great challenge to the irrigation of rice. Film hole irrigation method is just a suitable key to this existing problem. Film hole is also less expensive, which makes it suitable for promotion in rural India.

(3) Drip Irrigation

India suffers from severe water shortage, especially in its southern regions such as Tamil Nadu. The lack of water resources has seriously hampered domestic rice production. Despite the pessimistic current situation, practice has shown that drip irrigation is capable of reducing water consumption and increasing rice yield. Take 69 years Mr. Arthasarathy who won the Innovative Farmer Award in Hyderabab for example, by applying drip irrigation at a large scale in rice cultivation, he has not only saved 45% of water but also increased rice yield by 50%. [10]

Drip irrigation equipment mainly includes valves, pipes, connectors and driplines. There are two types of drip irrigation, micro-sprinkler irrigation as well as subsurface drip irrigation. The latter use irrigation strips buried under the roots of row crops like rice. Showing remarkable effect on saving water, drip irrigation is more and more popular among water-starved areas.

The following pictures show the basic components of drip irrigation.

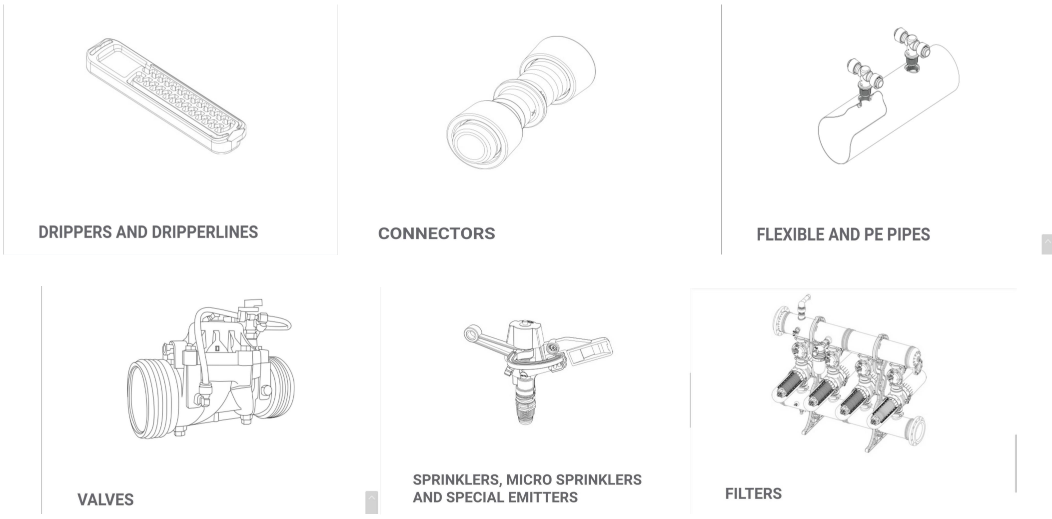

Fig Ⅰ. Drip Irrigation Components [14]

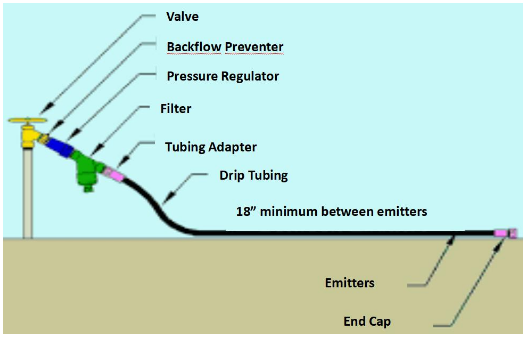

Fig 2. Component of Drip Tube [15]

Drip Irrigation can increase rice yield by 50%, up to 12 tons per hectare. With the traditional way of irrigation, the level of harmful arsenic soars because of flooded rice roots. Drip irrigation is able to reduce arsenic absorption by up to 90% by keeping the roots from submerged.

As was mentioned above, drip irrigation is an exceptional water-saver. It has been proved to save water by 50%, and thereby increase rice yield by 25%. By using conventional irrigation method, it takes 5,000 m^3 water to produce 1 ton of rice, while drip irrigation only requires 1,500 m^3 water. In addition, drip irrigation can reduce evaporation, runoff and infiltrate of irrigation water which should be absorbed by rice plants.

Because of the high cost of drip irrigation technology, farmers with rich experience can be selected to ration the equipment of drip irrigation at a low price. When the increase of rice production brought by drip irrigation has significantly increased their income, government can collect taxes from them for the use of technology, thus accumulating funds for the promotion of drip irrigation technology. The government can also reduce the cost of drip irrigation by recruiting and subsidizing high-tech companies which are willing to improve this technology. Peasants and citizens could try to improve the existing irrigation techniques and post their accomplishments to the local governments in order to reduce the cost as well as help government promote the technologies.

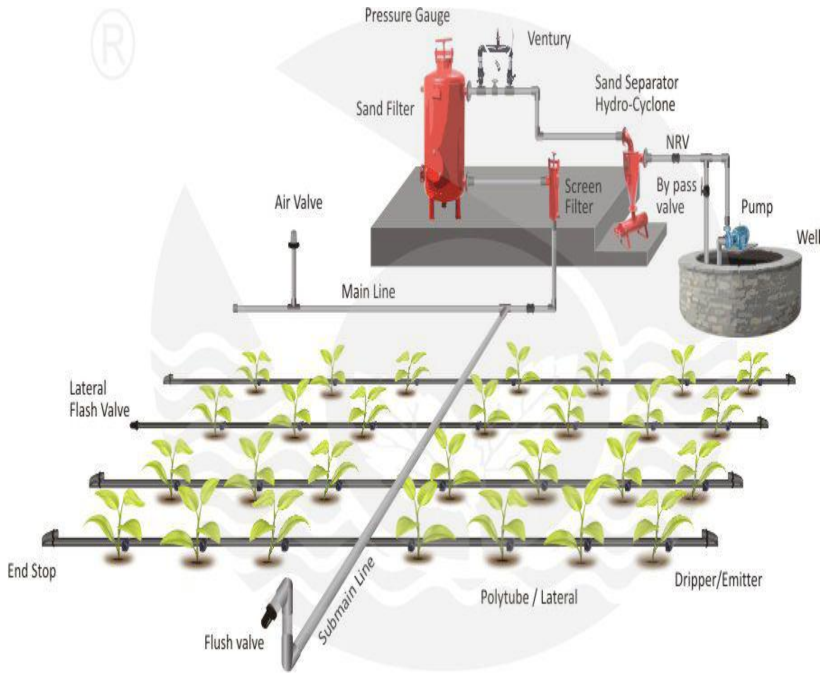

Fig Ⅲ. Sketch of Drip Irrigation [16]

Last but not least, drip irrigation sends water and nutrients directly to the rice roots, avoiding underwater pollution.

3.3.2 Adoption of Fine Breed: Sea-Rice

Sea-rice is a rice variety situated between wild and cultivated rice, mostly planted in coastal flat areas. Sea-rice is able to adapt to quite harsh conditions, taking pride in its strong resistance to salt and alkaline, water logging, pest disease and lodging.[17] By applying sea-rice at a large scale in land with salt and alkaline, the survival rate of rice can be greatly increased, thereby improving rice yield. The following experiment conducted by Guangdong Ocean University successfully proved the remarkable resistance of sea-rice to salt stress.

Fig IV. Categories of Ingredients [18]

Species	Quality
Pokkali	Strong resistance to salt stress (sea-rice)
FL478	Ordinary resistance to salt stress&Photosensitive blunt (sea-rice)
JX99	Strong resistance to salt stress&Photosensitive blunt (sea-rice)
IR29	Salt-sensitive (ordinary rice)

Fig V. Experimental Procedure [18]

1.Set 6 gradients of salt. (0,1,2,3,4,5g/kg^{-1})
2.Plant the 4 varieties of rice seeds in pots and raise them at the same condition. Change the level of salt stress at the same time during the growth of seeds.
3.Test 8 physical indexes(2 representatives: chlorophyll & soluble sugar) & draw solution.

With the increase of salt content in soil, the chlorophyll content of all four varieties dropped, while different kinds of seeds reacted differently to the same content of salt in soil. [18]

As soil salinity increases， the change of soluble sugar content varies; the soluble sugar content of JX99, IR29 and Pokkali all rise, while that of FL478 first rises and then descends. Under the salt stress of 0~3$g \cdot kg^{-1}$, the soluble sugar content of salt-sensitive rice 'IR29' was significantly higher than that of sea-rice.However, when the stress rises to 4-5$g \cdot kg^{-1}$, it's sea-rice (Pokkali and JX99) which has higher soluble sugar content. This indicates that salt stress promotes the synthesis and accumulation of soluble sugar in sea-rice plants, as the soil salt content increases, more soluble sugar is accumulated in sea-rice in order to alleviate the damage to crops caused by salt stress.

Chapter 4. Summary

At present, India faces a large population and rising population density. As the most important staple food of India people, rice must be provided in sufficient quantity and quality, which requires the improvement of rice yield. The increase not only solves the problem of starvation, but also promotes the transformation and upgrading of Indian agriculture, and therefore boost national economy through exportation. This article tries to analyse the reason for peasants' low scientific and cultural qualities from the perspective of history and convention. Then, based on Indian current regulations, give advice to promoting farmers' education in order to increase rice yield nationwide. In addition, by comprehensively applying the three irrigation methods mentioned in above paragraphs, this article is dedicated in increasing rice yield in some key parts of India.

References

[1] Sushruth Sunder. India Economic Survey 2018: Farmers Gain as Agriculture Mechanisation Speeds Up, But More R&D Needed[EB/OL]. https://www.financialexpress.com/budget/india-economic-survey-2018-for-farmers-agriculture-gdp-msp/1034266/, 2018-01-29/2020-06-29.

[2] 中商产业研究院. 2016 年世界大米总产量前十国家排行榜[EB/OL]. https://top.askci.com/news/20170824/093443106125.shtml., 2017-08-24/2020-06-29.

[3] 中国粮油信息网. 2018/19 年度印度大米产量数据下调到 1.1563 亿吨[EB/OL]. www.chinagrain.cn/axfwnh/2019/06/20/0808892476.shtml., 2019-06-20/2020-06-29.

[4] Population Institute of East-West Centre. How Female Literacy Affects Fertility: The Case of India[EB/OL]. https://www.eastwestcenter.org/fileadmin/stored/pdfs/p&p015.pdf, 1990-12/2020-06-29.

[5] India Government Internet. Farmers' Training[EB/OL]. https://archive.india.gov.in/citizen/agriculture/index.php?id=51, 2011-03-01/2020-06-29.

[6] 印度：失败的土地制度改革[J]. 乡村振兴杂志(中国共产党四川省委员会《四川党的建设》杂志社), 2019 (9).

[7] Hardin Lowell S. Meetings That Changed the World: Bellagio 1969: The Green Revolution[J]. Nature, 2008 : 470-471.

[8] 世界粮农组织. 世界粮食安全和营养状况报告[M]. 2017.

[9] 世界盐碱地的分布[EB/OL]. https://wenku.baidu.com/view/3eb84a7becfdc8d376eeaeaad1f34693daef10ba.html. 2020-05-17/2020-06-29.

[10] 向安强，贾兵强，林楠，等. 国外农民教育及其对“科教兴村”的启示[J]. 古今农业, 2005 (3) : 11-18.

[11] S.K.Ray. Land System and Its Reform in India[M]. India Journal of Agriculture Economy, 1996 (51).

[12] Pinoy Rice Knowledge Bank. What is Controlled Irrigation?[EB/OL]. https://www.pinoyrice.com, time unknown/2020-6-29.

[13] 朱兴曦. 宁夏引黄灌区水稻节水控灌技术应用研究[D]. 西安：西安理工大学, 2003.

[14] https://www.netafimindia.com.

[15] https://www.pinterest.com/pin/445645325605067759/.

[16] Donna Boyle Schwartz. Ditch the Hose with a Drip Irrigation System[EB/OL]. https://www.bobvila.com/articles/install-drip-irrigation/, time unknown/2020-6-29.

[17] 陈启彪，梁慧琳，陈俏媛，等. 新型海水稻的介绍[J]. Agricultural Technology Service, 2016 (6): 17.

[18] 王旭明，赵夏夏，陈景阳，等. 盐胁迫下海水稻抗逆生理响应分析[J]. 中国生态农业学报, 2019 (5) : 747-756.

Acknowledgements

I would like to pay tribute to Mrs Gao Wenfang and Mr Li Bo. With their patient academic help, I learned to be rigorous while doing research and writing this article.

In addition, I want to show my sincere thanks to Mr Jia Zhifeng and Mr Liu Yi. They have guided me along the way of working on this thesis, too.

Finally, thanks to Shijiazhuang Foreign Language School for offering this precious opportunity of taking part in the World Food Prize Global Youth Institute to me, which gave me the chance to show my concern on food problems in the perspective of our globe.

Last but not least, I would like to show thanks to my dear parents and classmates for supporting and encouraging me during the process of my thesis writing.