China's Agricultural Development: Adaptation in Action

World Resources Report Case Study

LANYING WANG, STATE OFFICE OF COMPREHENSIVE AGRICULTURAL DEVELOPMENT, CHINA
QUN LI, THE WORLD BANK

Suggested Citation: Wang, Lanying and Qun Li. "World Resources Report Case Study. Adaptation to Climate Change in Action in China's Agricultural Development." World Resources Report, Washington DC. Available online at http://www.worldresourcesreport.org

INTRODUCTION

The central government of China has in recent years allocated special funding for activities collectively known as comprehensive agricultural development (CAD). These activities aim to support agricultural and ecological development, strengthen agricultural infrastructure, ensure national food security, advance agro-processing production, and increase the income of farmers.

CAD's organizational structure is well established, with offices at the provincial, municipal, and county levels. It is led by the national government, while farmers are the major players on the ground. The State Office of Comprehensive Agricultural Development is a Department within the Ministry of Finance, and most of the comprehensive agricultural institutions at the provincial, prefecture, and county level are affiliated to the government finance sector. A working mechanism is in place, based on mutual coordination and support of various sectors, including finance, agriculture, water resources, forestry, and banks, as well as the National Development and Reform Commission (NDRC). Since CAD's implementation in 1988, its fiscal investment has gradually increased year after year. In 2010, the central government's annual budgetary fund for CAD reached RMB 19 billion (US$2.9 billion[1]) and the scope of the program covered 3 municipalities and 2,167 counties in 31 provinces and autonomous regions, as well as large Land Reclamation Bureaus in Xinjiang, Heilongjiang and Guangdong.

The World Bank-financed Irrigated Agriculture Intensification Loan III Project (IAIL3), implemented by the State Office for Comprehensive Agricultural Development (SOCAD), is a large-scale CAD project jointly implemented by CAD offices at various levels and related line agencies in the five provinces of the 3H Plain (the Yellow, Huaihe and Haihe River basins): Hebei, Jiangsu, Anhui, Shandong and Henan. From 2005 to 2010, the project was implemented with a total investment of US$463 million. It is an important component of CAD in China, involving 107 counties in the five provinces, aimed at improving 505,505 hectare of low- and medium-yielding farmland improvement and benefitting 1.3 million farmers.

IAIL3 was designed in 2004-2005 based on the scarcity of water resources in the provinces and the challenges faced in agricultural production after China's entry into the World Trade Organization (WTO). With the improvement of low- and medium-yielding farmland as the mainstay, IAIL3

[1] All US dollar estimates are based on exchange rates as of June 2011.

aimed to improve agricultural development with a particular focus on scientific water use and management. Even though many IAIL3 activities were climate sensitive and several reflected to some extent the principles of adaptation to climate change, the overall project design lacked in-depth understanding about the necessity of adaptation and adequate consideration of adaptation measures. The project's original design did not systematically integrate risks posed by climate change in all activities of project construction or in the design of specific engineering work plans.

In recent years, project management officials at various levels of the CAD system and farmers in project areas have felt an increased impact of climate change on agricultural production and people's lives; hence, adaptation to climate change in comprehensive agricultural development is becoming increasingly pressing. Therefore, in 2006, with special technical assistance from the World Bank IAIL3 Task team, the State Office for Comprehensive Agricultural Development requested a grant from the Global Environmental Facility (GEF) for the project *Mainstreaming Climate Change Adaptation in Irrigated Agriculture*, which aims to incorporate climate change adaptation actions into the ongoing World Bank-supported IAIL3. Plans for the remaining IAIL3 funding were reexamined and project activities were adjusted to improve and enhance existing adaptation measures and add measures not included in the original design. Thus, measures to adapt to climate change were introduced to water resource management and agricultural development. Through awareness raising, capacity building, and the demonstration of adaptation measures, the GEF project has increased adaptive capacity in agricultural production in the 3H Plain as a harbinger of more widespread use of adaptation measures in agriculture. Using lessons learned from the 3H Plain, the GEF project will provide trials and demonstrations related to the mainstreaming climate change adaptation in CAD projects nationwide.

As a program that addresses agricultural, rural, and farmers' issues, CAD has unique advantages in delivering adaptation activities. In addition, cooperation with top research institutions in China has provided solid technical support for implementing the GEF project. The activities to strengthen adaptation to climate change in IAIL3 have resulted in the following primary results:

1. Stakeholders in the project area have enhanced their understanding about climate change adaptation and adaptive capacity has increased;

2. Adaptation measures have been implemented with significant results achieved; and

3. Mainstreaming of adaptation to climate change in CAD is being implemented.

SETTING

The IAIL3 and GEF project areas are located in the 3H Plain, an important grain production base in China. The total area of the 3H Plain is about 350,000 km^2, its arable land area about 26.6% of the national total, and the sown area approximately 32.8% of the national total. The 3H Plain nurtures 32.3% of China's total population, and includes the entirety or parts of the seven provinces and municipalities of Beijing, Tianjin, Hebei, Shandong, Henan, Jiangsu, and Anhui. This is the area with the highest population density in the country, the agricultural zone with the largest area of vast flat land, and the major producing area of wheat, corn, cotton, and many other crops. Therefore, the 3H Plain is an important area for ensuring the country's food security.

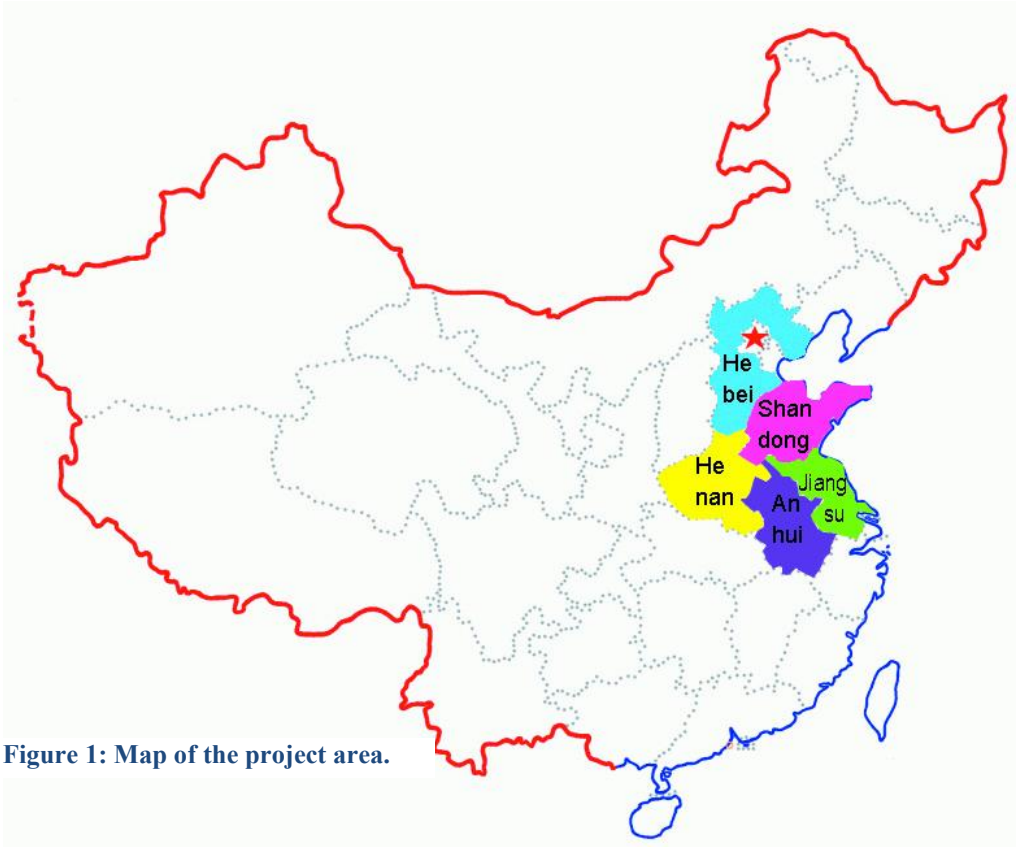


Figure 1: Map of the project area.

The 3H Plain is located in the monsoon climate zone of east Asia and is particularly prone to the impacts of climate change. China's per capita water resource availability is only 25% of the world average. Moreover, per capita water resource availability in the 3H Plain is only one third of the national average, which is half the standard defined by the United Nations for maintaining socioeconomic and environmental development. At present, available water resources in the region have been completely distributed and overexploited, and deterioration of water quality in some localities has aggravated the water scarcity. Future climate change will further reduce surface water runoff and the replenishment of groundwater in the region. At the same time, due to temperature increase and the associated increase in evapotranspiration of crops, demand for irrigation water will increase and exploration of groundwater will rise. Therefore, water resources in this region are significantly vulnerable to climate change. Meanwhile, low-efficiency water use and overexploitation of surface and groundwater in agricultural development of the 3H Plain have further aggravated the imbalance between water supply and demand. Prolonged stagnation of grain production in the 3H Plain is also closely related to climate change (Chinese Academy of Sciences, 2007).

The population engaged in agricultural production in the 3H Plain is the first to face the impacts of climate change. Rural women, and particularly women in poverty-stricken areas, are the most vulnerable to the risks, threats and disasters brought about by climate change, and therefore face the greatest challenges in responding and adapting. Accompanying the large-scale migration of young males in search of employment is the increased visibility of the "feminization of agriculture" in this region. In some areas, women make up as much as 70% to 80% of the agricultural labor force. When extreme climate events such as drought or flooding occur, rural women must make extra efforts in production. Climate change also increases the labor requirements of household chores of women. For example, it is usually the responsibility of women to fetch drinking water, prepare food and collect firewood, particularly after male laborers leave home for migrant employment. At the onset of drought or flood, women would have to traverse long distances to look for firewood or fetch water, which would inevitably take their time away from other income-generating activities (Hu Yukun, 2010).

To resolve the contradiction of water resource scarcity and the development of agricultural production, China used a World Bank loan for implementing the Irrigated Agriculture Intensification Loan Project (IAIL, 1991–1996) and Irrigated Agriculture Intensification Loan II Project (IAIL2, 1998–2002), in which studies and practices have been carried out for "true" water saving,[2] evapotranspiration management and integrated water-saving measures. On the basis of the success of IAIL1 and 2, IAIL3 invested 70% of its funding in the development of water-saving irrigation and agriculture. It aimed to achieve water saving through engineering, agronomic and management measures, and by advancing the organization of water user associations (WUAs) and specialized agricultural associations with the participation of women. Supplemented by the GEF grant, IAIL3 provided the framework and opportunity for introducing the idea of adaptation as well as specific adaptation measures into broader development planning.

TYPES OF RISK FACED

Over the past 50 years, the overall trend of climate warming in the 3H Plain has been clear, with increased frequency of extreme climate events and meteorological disasters. The mean temperature has increased by 1.18° C, an average annual increase of 0.02° C. When examining the variation of precipitation over the last 100 years, there were significant fluctuations among years and decades, while the overall trend of variation was not significant. However, north China is clearly becoming drier. In particular, the mean precipitation of the 3H Plain declined by 140 mm from 1956 to 2000, with an average annual decline of 2.92 mm (see Figure 1). Summer rainfall, which constitutes a large share of annual precipitation (about 60%), has decreased. The variation of precipitation frequency causes increased incidence of spring droughts, severely affecting crop growth as it makes water unavailable at the critical stage of crop growth and development (Tianzhan, 2006).

Following is an example using Jiangsu Province. From 1951 to 2005, the annual mean temperatures of the three regions of Huaibei, Jianghuai and Sunan of Jiangsu were 14.2° C, 14.8° C and 15.8° C, respectively; the annual mean temperatures of the last 10 years were 14.8° C, 15.5° C and 16.4° C, with an increase of 0.6° C, 0.7° C and 0.8° C, respectively. Increased temperature will lead to early maturity of crops in the region. Wheat varieties planted in the Suoyu District of Jiangsu Province in the past were mainly winter wheat with maturity around June 10. However, to adapt to local changes in climate, current wheat varieties planted in the region are winter and late spring varieties with maturity around June 5, an advance of five days (data provided by Jiangsu Provincial CAD Office).

In addition, over the past 20 years, the number of extreme climate events and meteorological disasters in the 3H Plain has increased. For instance, in 1991 and 1998, Jiangsu and Anhui provinces experienced once-in-a-century flood disasters. On February 13-14, 2009, the temperature in north Jiangsu reached 27-29°C, a new historical high. In summer, temperature increase affects the growth of paddy rice, and in 2003, in Quanjiao County, the high temperature caused rice production to drop by about 50%. In 2009-2010, low temperatures in winter and spring led to expanded frost damage of winter crops. For example, the harvest of wheat and rapeseed in Jiangsu and Anhui provinces was delayed by about 10 days, resulting in yield loss of these crops (data

[2] Water-saving in traditional agriculture mainly refers to engineering measures to increase the use rate of irrigation water. It counts the reduced leakage from improved use of irrigation water, backwater of ditches and drainage water of crop field as the amount of water saved. In fact, prior to the engineering measures, part of the so-called water saved is not lost but used in different forms downstream or by the ecological environment. Therefore, the purposeless evaporation-transpiration reduced through various measures is termed as the "true" amount of water saved.

provided by Jiangsu and Anhui Provincial CAD Offices).

The State Office of Comprehensive Agricultural Development commissioned the Chinese Academy of Sciences to use the report of the Intergovernmental Panel on Climate Change as the foundation to provide scenarios to characterize climate change in the 3H Plain in 2007. The results indicated that the warming trend of the 3H Plain during this century would continue. Climate change and related disasters will have significant impacts, through modifying moisture and thermal conditions, on the distribution of agricultural development, the structure of crop farming, and crop varieties and quality, hence threatening China's food security. Climate change is expected to have the following impacts on the 3H region:

- **Water resources**: Water supply is already expected to fall and water demand to rise due to factors other than climate change, such as increasing industrial and domestic demand. However, with the additional impacts of climate change, water use for all crops would increase, due to more evapotranspiration under the higher temperatures, and much of the 3H region could face a serious water deficit by 2030. In addition, flood frequency is projected to increase by 10% to 50% for all three river basins by 2030 (World Bank, 2010). In the coming four to five years, the probability of extreme precipitation events (floods), those that normally occurred once every 30-50 years, will be four to six times higher than it was from the 1980s to the 1990s. Predicting precipitation events is extremely complex. Over the long term, gross precipitation in the 3H Plain is predicted to increase. However, in the first 20 years of the 21st century, precipitation in some areas is predicted to decline and might become unstable (Chinese Academy of Sciences, 2007).

- **Agricultural production:** Future climate change variation will lead to more instability of grain production and crop yield fluctuation will increase. Water scarcity, which will be exacerbated by climate change, will lead to water reallocation and changes in cropping patterns, with the irrigated crop area projected to decrease. Future climate patterns will be characterized by more severe floods, with high-intensity storms severely affecting crop production. Drought risk would also increase most during autumn, followed by summer and spring in most areas of the region. The effects of drought are the most damaging in spring, the driest season, and summer, the main crop planting seasons (World Bank, 2010). When the climate becomes warmer, the decomposition of soil organic matter by microorganisms will accelerate, decreasing land fertility, which means that more fertilizer will be needed to meet grain production needs. Furthermore, due to temperature increase, the occurrence of various pests might extend to higher altitude areas (Chinese Academy of Sciences, 2007). The pathogens and parasites that are presently confined to tropical areas will creep up to sub-tropical or even to temperate zones. This will inevitably lead to increased application of pesticides and herbicides, which will significantly increase the cost of grain production. The boundary of crops will extend further to the north. The winter wheat varieties presently used in the 3H region will have to be replaced by semi-winter or spring wheat varieties since winters will not be cold enough for sufficient periods of time to meet the low-temperature requirement for vernalization, the most critical stage of growth for the wheat crop. In all, the increased uncertainty of climate change and the increased frequency of extreme climatic events will have negative impacts on agricultural production - average yields of the main cereal crops (rice, wheat and maize) are expected to decline (World Bank, 2010).

- **Life of farmers**: The declining agricultural production outlined above will directly affect the lives of farmers. If scientific adaptation measures are not adopted in a timely manner, farmers' incomes will significantly decrease, forcing some farmers into poverty.

POLICY INTERVENTION

As described above, the North China Plain (3H Basin) is particularly vulnerable to the impact of climate change. It has been shown that stagnant grain production for a number of consecutive years in the sub-region of 3H Basin is linked to climate change. However, past interventions generally have not addressed climate change and how to adapt to it. Such is the case with the ongoing national CAD program and the related World Bank-supported IAIL3 project in the 3H Basin. In 2006, the project management team (both the World Bank task team and SOCAD project management team) realized that remedial measures need to be taken quickly to ameliorate these impacts. In addition, climate change adaptation has become an important national priority in China, but it may take quite a long time to implement adaptation measures for thousands of small-scale production farmers in a large farm field, due to lack of knowledge of climate change, little practical adaptation experience, and institutional arrangements. IAIL3 is unusually well-suited to introduce and demonstrate adaptation measures through its investment activities in the field, and the World Bank is well-positioned in this field to provide knowledge and institutional experience gained from its programs worldwide. In June 2006, the World Bank task team initiated a draft CC adaptation project proposal to support implementation of adaptation measures under the IAIL3 project. The proposal was approved by the Global Environment Facility (GEF), with the support of the State Office of Comprehensive Agricultural Development and Chinese climate change experts, and implementation started in September 2007. The total investment was US$5 million.

The project aims to (a) strengthen the resilience of agricultural development in the face of climate change in China through implementing adaptation measures at demonstration sites; and (b) mainstream climate change adaptation into irrigation, water resource management, agriculture, and the overall context of rural development.

As the executing agency of the project, the World Bank task team mobilized worldwide expertise on a wide range of aspects related to the adaptation to climate change in water and agriculture sectors to assist in both project preparation and implementation. As the leading implementation agency, the State Office of Comprehensive Agricultural Development organized national scientists and local provincial experts to closely work together with the Bank's international expert team's assistance to assess climate change impacts, identify cost-effective measures and priorities for adaptation, and to address gaps in the original design of IAIL3. In particular, the team completed an early assessment of climate change impacts on water and agriculture production in each typical sub-region of the 3H Basin during project preparation, in order to identify adaptation gaps in ongoing development interventions.

The adaptation projects enabled the State Office of Comprehensive Agricultural Development to identify priority adaptation issues and develop, test, select, and demonstrate cost-effective adaptation measures, and the project approach helped:

- Identify adaptation gaps in ongoing projects, especially IAIL3 and the national CAD investment program.

- Provide an adaptation framework for comprehensive and cross-sectoral interventions.

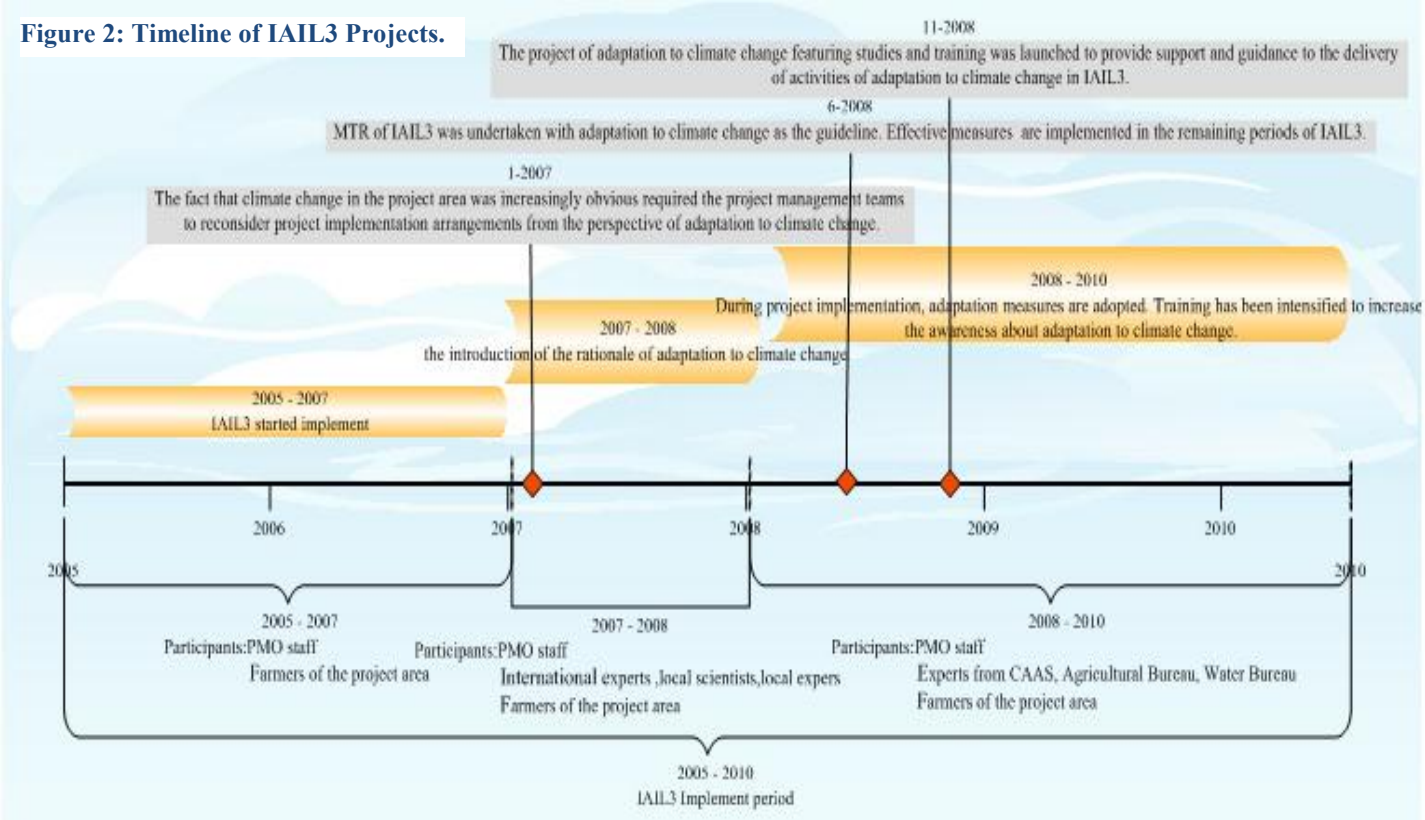
- Support institutional capacity building and public awareness.
- Create a favorable environment for integrated water resource management and the replication of good agriculture adaptation practices needed to ensure the sustainability of irrigated agriculture development.
- Facilitate reconsideration by decision-makers of current growth and development patterns and major infrastructure investments in view of climate change adaptation needs.
- Offer a clear demonstration and path to mainstream adaptation measures in the major ongoing national CAD program.

Wheat

On September 10, 2010, villager Liu Yuliang of Sancha Village, Gaoliu Township, Xinyi Municipality in Jiangsu Province enthusiastically told his story to the World Bank supervision mission. "This year, I planted *Xuzhou Wheat No. 31* and the yield is over 500 kg!" Once the new wheat variety that brought good harvest to villagers was mentioned, villagers spoke out. "Last year, no one dared to plant it, but this year everyone wanted to plant it. This is indeed a great favor the project did for us!"

The project referred to by the villagers was the IAIL3. After the early assessment of adaptation gaps was completed, the Provincial Office for

Figure 2: Timeline of IAIL3 Projects.



Comprehensive Agricultural Development hired local agriculture, water resources, and forestry experts to promote the use of those measures that were in line with local conditions. The wheat variety *Xuzhou Wheat No. 31* mentioned earlier is a drought- and pest-resistant wheat variety selected during project implementation.

Feng Guohua, an expert of the Xuzhou Municipal Agricultural Research Institute, said that Xinyi was located in a temperate humid climate zone where winter wheat had dominated in the past. However, in order to respond to the warming climate, when sowing wheat in 2009, the semi-winter and semi-winter spring wheat variety *Xuzhou Wheat No. 31* wheat variety was selected in accordance with the climate of Xinyi.

"We had been using the same old wheat variety for several decades, and many villagers dared not suddenly use the new variety, because they were afraid of the risks," explained Yu Shoudong, a villager of Sancha Village. However, Tang Xuerang, the leader of Sancha Village, told a reporter that at this critical moment, leaders of the Villagers' Committee championed and used the new wheat variety. Due to high levels of precipitation in 2009, many conventional crops could not withstand the conditions, leading to crop failure. The new wheat variety, however, produced full seeds with almost no failure.

Facts on the ground are always the most convincing evidence. Witnessing the high yield of the new wheat variety and the corresponding increased incomes, villagers were inspired to take action. This year, Sancha Village bought in 15,332 kg seeds of *Xuzhou Wheat No. 31* and planted 81 hectare for demonstration and extension. Yu Shoudong and other villagers who benefited from the new variety said: "We will continue to expand the acreage of the variety next year!"

Water

In Gaoliu Township, many more adaptation measures have been adopted. Setting foot on the fields of Gaoliu, one discovers special ditches and weirs, which are regularly distributed and carefully arranged. "This is the water harvest works of water-stopping walls constructed through the project," Zhao Xiaoling, chairperson of the Sancha Village water users association, explained to the World Bank supervision mission. Given that water resources are becoming scarcer and scarcer, Xinyi municipality carried out experiments in Gaoliu Township using the water-stopping wall as a water-saving measure. Farmers deepened the medium and small ditches by 50 cm and gradient walls were constructed at an interval of 400 m, with each wall able to store up to 816 m^3 of water. When the stored water level is higher than the wall, automatic overflow occurs. In order to ensure drainage, the water-stopping wall can store some of the irrigation water in the ditches.

Figure 3: Water harvesting using flip gates, canals, and on-field storage (World Bank, 2011).

Although simple, the water-stopping walls can prevent the discharge of pesticides and chemical fertilizers into water bodies, in addition to maintaining an appropriate water table. Xinyi has

constructed 17 new sluices, which can increase irrigation water storage by 850,000 m^3 each year. These "small" improvements, along with other water-saving measures, have increased the water production rate from 1.14 kg to 1.5 kg/per m^3.

"The project also assisted us in establishing a water users association, offered training to us, and enabled women to master some technical knowledge of water-saving irrigation. It helped us upgrade the capacity of water management and use. Because women make up 40% of water user associations' members, they can help us organize irrigation during the busy farming season, and men can continue their employment in urban areas without worrying about their farmland," the outspoken water user association chairperson told us. "In the past, when we needed water for irrigation, we first had to fight for it; second, we had to fight for it quickly; and third, nobody managed water use. During each busy farming season, we 'broke our heads' for water. Once the irrigation season was over, no one took care of the facilities, which led to the aging of water conservation and irrigation facilities. Large areas of farmland were left uncultivated since there was no water for irrigation. But now the ponds are full of clear water, and the ditches are dredged. We no longer need to fight for water, all the wheat fields in the village can be irrigated and production has reached historical new highs."

Education and Outreach

Figure 4: Farmer consultations in Hebei (World Bank, 2011).

The training mentioned by the chairperson was an important element of project implementation. To address low awareness about climate change, the State Office for Comprehensive Agricultural Development recruited experts from the Department of Climate Change of the National Development and Reform Commission, the China Clean Development Mechanism (CDM) Fund Management Center, and the Chinese Academy of Agricultural Sciences to deliver training. The training included presentations on the Copenhagen Climate Change Conference, as well as the latest work undertaken on climate change, to ensure that project management staffers at the provincial, municipal, and county levels can closely follow the latest developments and smoothly promote project implementation. At the same time, the State Office for Comprehensive Agricultural Development and the World Bank recruited experts from China Agricultural University (CAU) and a non-profit organization, the Home of Rural Women, to deliver targeted training to women, granting particular attention to the more active role they play in the project and adaptation activities.

OUTCOME

By the end of December 2010, IAIL3 had a cumulative completed investment of RMB 3.8 billion (US$587 million). Improvements have occurred in 505,500 hectare of low- and medium-yielding farmland and 941, 526 hectare of crop sow area. Almost 25,000 hectare of wind-breaking forest have been planted. More than one thousand water user associations have been set up, along with 209 farmers' specialized associations[3] and 20 farmers' specialized cooperatives[4]. Finally, 256 research and experimental/demonstration activities focusing on practical themes related to the selection and testing of adaptation measures in rural water management, advanced agriculture technologies, and gender and institutional development have been implemented.

Project implementation has generally improved agricultural infrastructure facilities in the project area. The adoption of suitable climate change measures has further increased the capacity of the project area to defend against natural disasters. In February 2009, a once-every-50-year winter drought occurred in Huaiyuan County of Anhui Province. Thanks to well-established irrigation facilities, all wheat crops in the IAIL3 project area were irrigated before February 10, which was five days sooner on average than the rest of the counties in Anhui. For example, in Wasi Village of Chengji Township, the World Bank project helped build 60 shaft wells, and it took only five days to irrigate the 467 hectare of wheat in the village. The quality of wheat seedling was preserved, and no damage was caused by the drought.

Project implementation has increased farmers' income and played a demonstration role in the development of non-project villages. In Xinyi Municipality of Jiangsu Province, the Caoqiao project area built 135 hectare of greenhouses in 2009. Planting of off-season popular vegetables, such as cucumbers, eggplants, and peppers increased the income of each mu of land[5] to RMB 50,000 (US$7,725). The 40,000 m^2 of greenhouses and 800 biogas digesters built in the demonstration county of Shandong Province have also achieved good economic benefits. The per capita income of farmers in the project area has increased significantly. After witnessing the practical and tangible benefits, some farmers in the surrounding areas of the project began building biogas digesters and greenhouses at their own expense.

Project implementation has increased both awareness about adaptation to climate change as well as the capacity to adapt to climate change. The effectiveness of the adaptation measures has been verified and is evident through comparisons of project and non-project areas. Farmers have been able to reap the benefits brought about by adaptation measures, encouraging them to take the initiative to think about how to cope with climate change and actively promote project implementation.

After the concept of adaptation was introduced to IAIL3, project provinces immediately began implementing adaptation measures. The State Office for Comprehensive Agricultural Development reported to State Council leaders about the work being done in adapting to climate change in CAD, and the reports were copied to the Ministry of Water Resources, Ministry of Agriculture, Ministry of Land and Resources, Forestry Administration, and the China Federation of the Cooperative of Supply and Marketing, as well as to the CAD system nationwide. In August 2009, the Xinyi Municipal People's government of Jiangsu Province, in a farmland project proposal,

[3] A farmers' specialized association is similar to agricultural service cooperatives, which provide various services to their individual farmer members; it is a non-profit organization.

[4] A farmers' specialized cooperative is an agricultural cooperative, also known as a farmers' co-op, where farmers pool their resources in certain areas of activity.

[5] 1 mu is approximately 667 m^2.

explicitly mentioned that high standard farmland construction must "uphold the principle of adaptation to climate change and achieve lasting effects." The deployment of water resources, as well as agricultural and forestry measures, shall be compatible with future climate change trends in order to reduce damage brought about by extreme climate disasters and to make projects sustainable. The Anhui Project Management Office delivered comprehensive training to the IAIL3 project management staffers, and participants achieved breakthroughs in understanding adaptation to climate change. The principle and investment criteria of adaptation to climate change have been included in the Anhui provincial CAD investment guideline, which has requested that all local CAD project proposals or technical designs need to take into consideration adaptation to climate change in the field. This has resulted in mainstreaming adaptation into the overall provincial domestic program: adaptation measures will be expanded from the 16 counties under IAIL3 project area to 93 counties, and the affected area will be extended from 72.6 thousand hectare to 2.7 million hectare, with the number of farms benefitting increasing from 1 million to 30.8 million in Anhui alone. The directors of the CAD bureaus at various levels expressed that more attention will be given to climate change issues in future work. The concept of adaptation to climate change will be introduced to CAD projects, so as to popularize adaptation throughout the provinces.

Climate change should not simply be seen as an unfavorable condition for development. If we use reverse thinking, adaptation to climate change and finding the "comparative advantage" of climate change can serve agricultural production.

Zhao Fengshu, Director of the Xinyi Municipal Agricultural Resource Development Bureau

FACTORS THAT FACILITATED GOVERNMENT ACTION

IAIL3 was financed by the World Bank and implemented by the State Office for Comprehensive Agricultural Development with the participation of multiple sectors, such as the water resources management, agriculture, and forestry sectors. The smooth implementation and achievements of the project are attributable to the following factors:

- **Large-scale adaptation work done by the Chinese government has created a favorable mega environment for the delivery of adaptation activities in 3H Basin:** The Chinese government attaches great importance to the issue of climate change. It has been consistently and actively participating in activities under the UN Framework Convention on Climate Convention (UNFCCC) and the Kyoto Protocol. In 2004, China issued the Initial State Information Report on Climate Change of the People's Republic of China. For the first time, it proposed a list of needs for adaptation technologies. China also issued the National Plan for Coping with Climate Change in June 2007; the National Assessment Report of Climate Change and the Science and Technology Action Plan on Climate Change in 2007; and the white paper on China's Policies and Actions for Addressing Climate Change in 2008. In these activities, China has not only explicitly proposed policies and measures to mitigate climate change, but has also gradually improved its capacity to adapt to climate change, strengthened research related to adaptation, and continuously enhanced policies and measures related to adaptation institutions and mechanisms. On September 22, 2009, President Hu Jintao attended the UN Climate Change Summit in New York and made an important speech at the opening ceremony entitled, "Join Hands to Address Climate Challenge." He clearly stated that China would further

incorporate adaptation to climate change into socioeconomic development planning and continue to adopt forceful measures. Therefore, the adaptation work currently being implemented in CAD programs in the six provinces of Hebei, Shandong, Henan, Jiangsu, Anhui and Ningxia is a tangible manifestation of President Hu Jintao's commitment.

- **CAD has a solid foundation for the application of adaptation activities:** Adaptation to climate change in agriculture involves multiple sectors. The most outstanding feature of CAD is "integration," i.e., the coordinated action of the finance, agriculture, forestry, water resources, and land resources sectors, which are responsible for important strategic decision making about CAD in the country. Because the State Office for Comprehensive Agricultural Development is the implementing agency of IAIL3, it is very influential in the provinces and maintains close working relations with relevant agencies dealing with climate change in the central government, including the Ministry of Water Resources, Ministry of Agriculture, and the National Forestry Administration. This provides the necessary conditions for the smooth implementation of adaptation measures in the CAD system.

  Second, CAD has a solid foundation because of its achievements in past years. It has a well-established institutional setup from the central to the provincial, municipal, and county levels, and its project area covers the entire country. It plays an important role in agricultural development, increasing farmers' income and ensuring the nation's food security. CAD projects and staffers enjoy good reputations among farmers. Farmers of the project areas praised CAD as a program that seeks tangible benefits for farmers, and provides a reliable channel to deliver the new concepts and work of adaptation to climate change in agriculture.

  Third, CAD has rich project management experiences with World Bank projects and funding. It closely combines its principles and policies with the advanced management methods of World Bank projects. It merges the successful experiences of modern agriculture in other countries with the realities of rural China, ensuring effective project implementation and improving fund use efficiency. The "standardization" of CAD management will also play an important role in guaranteeing the effective operation of adaptation projects and the effective use of funding from various channels.

- **IAIL3 has provided strategic insight for the delivery of adaptation measures:** In order to genuinely combine the IAIL3 and GEF projects, the World Bank task team and the State Office for Comprehensive Agricultural Development treated the issue of adaptation as an important starting point for the IAIL3 mid-term review and adjustment of technical design and investment activities. From the adaptation perspective, the State Office for Comprehensive Agricultural Development reexamined and adjusted the design for the remaining funding of IAIL3. Based on research results carried out during the preparatory stage of the project, efforts were made to beef up adaptation measures, so as to strive for better incorporation of adaptation in IAIL3 activities.

- **Various methods have been used to spread awareness about and engage farmers in adaptation activities:** Provincial Project Management Offices have distributed material about global climate change and China's policies for coping with it to farmers in the IAIL3 project areas and some non-project villages, in order to increase awareness about

adaptation. Meanwhile, questionnaires were administered to farmers to solicit their views and suggestions on adaptation measures to ensure that they are both technically sound and based on the will of the farmers. Surveys were also carried out concerning subsidizing greenhouses and the construction of biogas digesters. The Huaiyuan County Project Management Office of Anhui Province organized a visit to the Huaiyuan Meteorological Station to allow farmers from neighboring areas to better understand climate change and its impact on agricultural production and the life of ordinary farmers.

- **Farmers' organizations have been developed:** Project Management Offices at various levels have emphasized the development of water user associations and farmers' specialized associations as an important element of project implementation. Financial subsidies have supported the establishment and development of farmers' organizations, which have been used as a platform to deliver trainings to stimulate farmers' enthusiasm to participate in the project and to boost adaptive capacity. Irrigation facilities that were constructed as part of the project were handed over to water users' associations so that farmers could take ownership of managing and maintaining the facilities, ensuring that farmers play an important role in adaptation activities.

- **Close cooperation with research institutions has provided strong scientific and technical support for project implementation:** The GEF grant was used to contract top research institutions in China and first-class international experts to build up the scientific base for project design, a new path of using scientific assessment to guide production practices. During project preparation, the expert group of the Chinese Academy of Sciences presented the results of over 20 years of research on precipitation and temperature. This was done in order to provide proposals and recommendations to the project design based on the scientific knowledge. Applying this research in the project design provided clear direction on how to effectively incorporate adaptation measures into CAD projects.

Second, experts at various levels and from different disciplines fully participated in project planning. On the basis of preparatory work, the State Office for Comprehensive Agricultural Development organized experts in related disciplines who went to the project area and assessed the impacts of climate change on agricultural production. Meanwhile, national and provincial Project Management Offices organized experts who analyzed adaptive measures in CAD projects and assessed the impact of climate warming on agriculture and coping measures. They also studied water resource management models within the context of climate change, as well as the ways in which the crop farming structure was adjusted.

Third, based on the results of this research, analysis, comparison, and screening were carried out for each adaptation measure, so as to identify those measures that best suit the features of different regions. Meanwhile, farmers were consulted in the selection of the adaptation measures, so that they complied with local realities and met the requirements of farmers of the project area.

Finally, special subject studies on adaptation to climate change organized by the provincial CAD offices and carried out by local experts were treated as an important element of project implementation. The State Office for Comprehensive Agricultural Development and the provincial Project Management Offices have delivered studies of adaptation to climate change at different levels, the results of which

have been used in guiding the adaptation activities in CAD.

BARRIERS TO ADOPTING AND ADVANCING THE INTERVENTION

Since the introduction of the concept of adaptation to climate change and the incorporation of adaptation measures in IAIL3 two years ago, many achievements have been noted and results are starting to emerge. However, some challenges in project implementation remain that must be addressed in the future.

- **Awareness must be further strengthened and methods changed:** CAD is an important measure for ensuring sustainable development in China, and project implementation should focus on the development of "solid strengths" such as improving low- and medium-yielding farmland and on-farm works through physical interventions. But the GEF project has placed more emphasis on the development of "soft strengths" such as the concepts of adaptation to climate change. The combination of the "soft" and "solid" elements is critical to project implementation and key to determining whether the project succeeds or fails. This therefore requires project management staffers who are used to the implementation of traditional CAD projects to increase their awareness about climate change and change their management approach. Through practical work and relevant training in the past two years, project management staffers at various levels have increased their confidence and capacity to undertake adaptation work. They have seen significant changes in farmers' production brought about by the project. However, in order to promote adaptation to climate change on a larger scale, awareness about climate change must be further enhanced and work styles must be improved to bring these two elements of project implementation together.

- **Continued technical innovation is necessary:** Most adaptation measures adopted by the IAIL3 project already existed in CAD, but were scattered and adopted arbitrarily. In order to better advance climate change adaptation in the field of irrigated agriculture and bring adaptation in CAD to a new high, the State Office for Comprehensive Agricultural Development must continue to actively explore new technologies and measures.

- **Better coordination between sectors and central agencies is needed**: The implementation of climate change adaptation in a large farm field in the irrigated agriculture sector needs close coordination and integration between the relevant technical sectors and central technical line agencies, including the Ministry of Water Resources, the Ministry of Agriculture, and the State Forestry Bureau. The level of integration must be increased in order to enhance the application of integrated technical adaptive measures, provide an adaptation framework for comprehensive and cross-sector intervention, and help to effectively replicate adaptation approaches in the wider context of agriculture development.

- **Existing adaptation measures must be continuously assessed and improved:** Adaptation to climate change is a new sphere, and whether or not current adaptation measures are effective needs to be verified on the ground. Therefore, the State Office for Comprehensive Agricultural Development must closely monitor results of the adopted adaptation measures in the demonstration areas so as to continuously improve them in line with realities on the ground. For example, the "water-stopping wall" used in the Xinyi Municipality of Jiangsu Province seems to have increased the utilization rate of irrigation water to some extent. However, its impacts on the groundwater table of

surrounding areas in the long run remain unclear and must be addressed in the future.

- **Research and application challenges**: Climate trend projection should play a stronger role in guiding project implementation. In order for adaptation to climate change in IAIL3 to be scientifically sound, the State Office for Comprehensive Agricultural Development recruited experts of the Chinese Academy of Sciences who used professional models to simulate and project the long-term trend of climate change in the project areas. Simulation results were the foundation for screening adaptation measures and guiding project implementation. However, in any given year, substantial degrees of uncertainty exist, which significantly impact the delivery of adaptation actions and results. For instance, if projected results indicated that the overall trend of climate change in the coming 20 years would be dominated by temperature increase, the selection of adaptation measures would then consider whether to fully take advantage of climate warming as a natural condition. In terms of crop variety and cropping structure, drought-resistant varieties would be popularized and winter wheat would be extended. Meanwhile, high-quality varieties with good adaptation characteristics would be bred, and facility agriculture (such as greenhouses) and biogas would be developed, all of which will be important adaptation measures in such a context. However, climate change in 2010 was experienced primarily as extreme climate events with significant temperature decline. Such a situation brings about tremendous difficulties for project implementation.

- **Detection of regional climate change risks is still relatively inadequate:** As adaptation measures have strong regional features, planning and implementation must be tailored to regional contexts. Since the research foundation is relatively weak for smaller areas, there is still insufficient understanding about the risks and uncertainties for any given region. For instance, studies regarding the change of temperature, precipitation and extreme climate events, as well as the potential risks associated with these changes, are inadequate at the county level. Therefore, it is necessary to strengthen knowledge of regional climate change risks and associated impacts, so as to provide a basis for better developing and integrating adaptation measures.

CONCLUSIONS AND LESSONS LEARNED

In the implementation of IAIL3, particularly since the introduction of climate change adaptation measures, Project Management Offices at various levels have strengthened cooperation with research institutions. Timely transformation of the latest research on climate change adaptation into practical action to guide adaptation practices in the project area is one of the project's highlights.

The farmers' active participation and interaction with Project Management Offices at various levels is another achievement of the project. In past years, project management staffers and local government made most of the decisions during project implementation, which was a reflection of administrative will. However, since adaptation to climate change is closely related to the life of farmers and to agricultural production, farmers in the project areas are the most authoritative ones to judge whether the adopted adaptation measures are effective and optimal. Therefore, Project Management Offices at various levels used a wall calendar and art performances to disseminate information about the project, which were well-received by farmers. Questionnaires and discussions were administered to solicit the opinions and suggestions of farmers in the project areas. Water user associations and farmers' specialized associations are being used to deliver training, and

evidence indicates that such an approach has achieved good results.

Supporting the development of water user associations, farmers' specialized associations, and cooperatives is also an achievement of the project. Since reform and opening, [6] the household responsibility system[7] has granted full autonomy to farmers. Along with the deepening of a market economy, thousands of small-scale farm households in China must be organized to cope with various risks associated with a market-based system. The project has provided great support in terms of training and funding to the farmers' organizations in the project area. Helping farmers help themselves will enable farmers' organizations to better deliver adaptation activities.

Through the implementation of adaptation activities and the large-scale training programs at various levels of government, the project management officials and the State Office for Comprehensive Agricultural Development leaders have genuinely realized the importance and imperativeness of these measures, as well as taking into account the needs of farmers in adapting to climate change. Adaptation to climate change is a systematic process that requires a far-reaching vision while attending to short-term objectives. The State Office for Comprehensive Agricultural Development must think about the future, in order to lay a solid foundation for successfully incorporating climate change adaptation into the overall national agriculture investment program.

[6] *Reform and opening* refers to the program of economic reforms called "Socialism with Chinese Characteristics" in the People's Republic of China that were started in December 1978 by reformists within the Communist Party of China led by Deng Xiaoping. The goal of Chinese economic reform was to transform China's stagnant, impoverished planned economy into a market economy capable of generating strong economic growth and increasing the well-being of Chinese citizens.

[7] The household-responsibility system divided the land of the People's communes into private plots. Farmers were able to keep the land's output. This move increased agricultural production, increased the living standards of hundreds of millions of farmers, and stimulated rural industry.

REFERENCES

Chinese Academy of Sciences. "Science-Based Understanding for GEF 'Mainstreaming Adaptation to Climate Change into Water Resources Management and Rural Development' Project Implementation Plan." 2007.

Ding Yihui, Ren Guoyu, Shi Guangyu. "National Climate Change Assessment Report (I): History and Future of Climate Change in China." *Advances in Climate Change Research*, 2006.

Hu Yukun. "China's Rural Women in the Shadow of Climate Change." *World Environment*, Issue 4, 2010.

National Development and Reform Commission of China. "China's National Programme to Address Climate Change," 2007.

Shao Xiaomei, Xu Yueqing, Yan Changrong. "Spatial and temporal distribution analysis of water balance in the Yellow River basin." *Climatic and Environmental Research*, 2007.

State Council of China, Information Office. "White paper: China's Policies and Actions on Climate Change," 2008.

Tianzhan."Research on the Relationship between Crop Productivity and Future Climate Change at 3H Plain," 2006.

Water Information Center, Ministry of Water Resources. "Special Report on Responses of Water Resources to Climate Change and Countermeasures." 1996.

World Bank. "China: Measuring and Coping with Climate Change and Its Impacts on Water and Agriculture in the 3H Region", 2010.

Xu Yinlong, Huang Xiaoying, Zhang Yong, et al. "Statistical analyses of climate change scenarios over China in the 21st century." *Advances in Climate Change Research*, 2005.

Yellow River Conservancy Commission. "Assessment Report of Climate Change Impact and Water Resources of the Yellow River Basin," 2008.

Zhang Yi. *Climate Change and Its Impacts*. Beijing: Meteorological Publishing House, 1993.

Zhang Yong, Xu Yinlong, Dong Wujie, Cao Lijuan. "Change of Extreme Precipitation Events in China in Future: An Analysis Based on Prediction of Climate Change." *Journal of Natural Disasters*, 2006.

Zhao Zongci. "Latest Advances in Global Climate Projections." *Advances of Climate Change Research*, 2006.