ECOSYSTEM-BASED ADAPTATION THROUGH SOUTH-SOUTH COOPERATION

GOOD PRACTICE CASE STUDY

Three Integrated Farming-Grazing Systems in Tibetan Plateau

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The region of Tibet in Southwest China is located on the Qinghai-Tibet Plateau, the highest and largest plateau in the world with an average elevation of over 4,000 m and an area of 1.2 million km^2. It is extremely vulnerable to climate change. In recent decades, average temperature and precipitation has increased regionally, while locally southern Tibet has observed a decrease in precipitation. The changing climate has caused shrinking permafrost and wetlands as well as impacts on alpine grassland, farmland and forest on which most people rely heavily. Moreover, poverty further exacerbates the sensitivity of local people to climate impacts.

This project targeted three villages in Tibet and aimed to increase the household's income by improving ecosystem services and local capacity to manage their natural resource-based livelihoods. The interventions included: i) improving agricultural techniques; ii) building integrated farming-grazing technology systems; iii) establishing community-based cooperatives and industries; and iv) training. This project successfully helped the villages in the aspects of economy, ecology, livelihoods and human capacity, among others, and all of those contributed positively in adapting to climate change.

Key lessons

(1) Improvement of ecosystem services

- For farming systems in Tibet: Multiple cropping in August to September and mixed seeding are two ways of increasing the productivity of croplands.
- For grazing systems in Tibet: First, in order to restore degraded grassland, seed selection of forage works more effectively than building irrigation systems due to the seasonally concentrated precipitation. Second, fencing with shallow tillage or without tillage is an optimized management method that could increase the productivity of forage cropland and also reduce the loss of carbon storage. Third, forage-feeding is a supplement of grazing. It helps in reducing the pressure of grazing pastures.
- For farming-forestry-grazing systems: Models of 'raising geese in corn farmland' and 'raising Tibetan pigs in the understory of forest' could increase the productivity of related ecosystems. Corn farmlands without fertilizer or pesticide may reduce the productivity of corns but would improve the ecological function and maximize profits from the integrated system.

(2) Livelihood diversification

Diversified livelihoods could help to adapt to climate change. In Bailang village, it developed the model of 'when rain is ample, sell forage; when drought occurs, feed sheep'. These two livelihoods help locals deal with different weather patterns.

(3) Establishment of cooperatives

- Establishing cooperatives is an important method that helps improve livelihoods of the communities by diversifying their livelihood options with consideration of traditional local knowledge, creating more profits by selling their products directly to the customers, and building social connections. These benefits are important to reduce the vulnerability to the impacts of climate change for locals.
- Cooperatives also have their own risks. According to the experience of Jina village, a good cooperative relies on its managers and the management of risk from the market. Therefore, improving the human capacity and the mechanisms of training are important for the development of cooperatives.

GOOD PRACTICE DESCRIPTION

LOCATION: Three villages in South Tibet and Southeast Tibet: Jina, Bailang and Zhangmai

IMPLEMENTATION PERIOD: 2013-2016

OPERATIONAL BUDGET: RMB 22.8 million

KEY STAKEHOLDERS:

The project was developed and funded by the Chinese Academy of Sciences (CAS), and was implemented by the Institute of Geographic Sciences and Natural Resources Research, CAS, and the Tibet Research Center for the Engineering and Technology of Alpine Grassland. Additionally, this project forms a part of the 'Science Technology Service Network Initiative'.

Partners: Institute of Microbiology, CAS; Institute of Subtropical Agriculture, CAS; China Agricultural University; Nanjing Agricultural University; Tibet Academy of Agricultural and Animal Husbandry Sciences; and Lanzhou Institute of Husbandry and Pharmaceutical Sciences, Chinese Academy of Agricultural Sciences (CAAS).

Background information

The region of Tibet is located on the Qinghai-Tibet Plateau in Southwest China. The plateau is the highest and largest in the world with an average elevation of over 4,000 m and an area of 1.2 million km^2. The region is also the origin of multiple vital rivers which affect approximately 40% of the world's population. The unique geology and topography of the plateau generate a rich biodiversity and considerable influence on the climate in southern Asia. Qinghai-Tibet Plateau is one of the most important hotspots of biodiversity in the world due to its unique topography and species (Myers et al., 2000). Studies showed that the early intensive uplifting of plateau, together with other factors like climate change, generated unique bio-geological environment in Himalayas, which in turn bred unique biotas, diverse ecosystems and ecological process in the region (Favre et al., 2015, Zhang et al., 2002). The plateau also induces and enforces the Southwest Monsoon in Asia (Ye & Gao, 1979).

Tibet has a total population of ~3 million, with 90% of the population being Tibetan (Sixth National Census, 2010). Approximately 32.95% of population live in poverty (Tibet Poverty Alleviation Office, 2014). In addition, as the dominant ecosystem in Tibet is alpine grassland, most people rely on traditional farming and grazing for their livelihoods.

This project consists of three subprojects. They were launched in the southern and south-eastern areas of Tibet at three selected Tibetan villages: Jina village, Bailang village, and Zhangmai village. The region is located in the Yarlung Zangbo River basin and ranges in elevation from 3,000 m to 4,000 m.

(1) Jina village is located at the Gangdui town, Gongga county (贡嘎县岗堆镇吉纳村). It is 20 km away from Gongga airport and 80 km from Lhasa (the capital of Tibet). The dominant ecosystems are alpine semi-arid shrubland and grassland. Jina village has 268 households with a total of 1,133 people. The average income of the village is similar to an average Tibetan farmer, who earns 5,000 RMB per year. Local people grow food crops and forage crops to make a living.

(2) Bailang village is located in a mountainous area of the Kazi, Linzhou county (林周县卡孜乡白朗村). It is also 80 km away from Lhasa. It is covered by the temperate semi-arid shrub and grassland. Bailang village has 155 households with a total of 877 people. The villagers' average annual income is 4,155 RMB, 17% lower than an average Tibetan farmer. Apart from the basic farming, the other main agriculture in Bailang village is grazing, which is supported by 93 km^2 of grasslands.

(3) Zhangmai village is located in the suburb of Bayi town, Linzhi county (林芝县八一镇章麦村). The Bayi town is the centre of the Linzhi county and is famous for tourism. The dominant ecosystem is subalpine forest. The village has rich forest resources. Zhangmai village has 60 households and 160 people, with an average annual income of 5,500 RMB, which is higher than the average level of Tibetan farmers. Young people from the village make a living by taking temporary jobs in the city nearby.

Climate change vulnerabilities

Tibet is extremely vulnerable to climate change. In recent decades, average temperature and precipitation has increased regionally, while locally southern Tibet has observed a decrease in precipitation. The changing climate has led to a shrinking of permafrost and wetlands, an increase in runoff, and an increase in the occurrence of natural disasters such as snowstorms and drought (Chen et al., 2015). Studies show that the warm-wet climate accounts for more than 80% of the change (increase) in grassland productivity between 1982 to 2001, while its effects decreased from 2001 to 2010 as the warm-dry climate reduced the productivity of alpine grassland (Chen et al., 2014).

In the three project villages, people rely heavily on farmlands, grasslands and forests to make a living. While affected by the impacts of climate change on their natural lands, poverty also exacerbates their sensitivity to climate impacts. Therefore, this project aims to increase locals' income by improving ecosystem services and local capacity to manage their natural resource-based livelihoods.

Intervention technologies

The project consists of four different types of interventions, namely: i) improving agricultural techniques; ii) building of integrated farming-grazing technology systems; iii) establishment of community-based cooperatives and industries; and iv) training. Separated but similar interventions have been taken in the three villages according to specific types of livelihoods.

(1) Improving agricultural techniques

- Applied multiple cropping to food cropland: Multiple cropping is a practice of farming intensification through various forms, such as intercropping, crop rotation and agroforestry. By increasing the diversity of crops, it improves nutrient cycling (e.g. nitrogen), soil fertility and thus the provision of agriculture products (Agriculture for impact, 2016, Gliessen, 1985, Vignola et al., 2015). In Jina village, CAS developed and applied five models of multiple cropping. For example, they applied crop rotation in the form of second-round cropping of legumes during August and September as to improve the nitrogen cycling and soil fertility in the farmland (Figure 1).
- Restored grassland and pastures: By applying different technologies, such as fencing, irrigation and fertilization, Bailang village restored 80 ha of spring/summer pastures and 67 ha of winter pastures from degraded grassland. These pastures are used for alpine transhumance of every family. In Zhangmai village, CAS restored the grassland through a type of rye (绿麦草), which is resilient under the dry and extreme weather. They also applied several technologies related to the management of grassland and pastures. These methods include increasing the diversity of forage grass and improving the sowing techniques (Figure 1).

Figure 1. Alpine mixed forage cropland (left), second-round cropping with grassland management techniques (right) ©CAS

(2) Building integrated farming-grazing systems

- Integrated farming-animal husbandry model: In Jina and Bailang villages, CAS developed a livelihood model of integrated farming-grazing systems, combining the forage farming and animal husbandry together within the same village. It intended to support the intensive animal husbandry for livestock, such as cattle and sheep, through self-supplied forage. CAS sponsored seed drills and harvest machines for forage farming. It also introduced Total Mixed Rations (TMRs) forage-packing technology to help farmers to store the harvested forage and waste straw while maintaining the nutrient of forage during winter. For animal husbandry, CAS introduced five feeding formulae to the farmers as to maximize the use of forage.
- Integrated farming-forestry-grazing model: In Zhangmai village, two types under this model were developed: 'raising geese in corn farmland' and 'raising Tibetan pigs in the understory of forest'. Suitable forage crops were planted in corn farmlands and the understory of forest. This model is intended to maximize the use of land and natural resources for agriculture.

Figure 2. Raising geese in corn farmland (left), raising Tibetan pigs in the understory of forest (right) ©CAS

(3) Establishing community-based cooperatives and industries

All three villages established their own agricultural cooperatives. In Jina village, farmers contributed a number of their own cows and part of their land to their cooperative. The cooperative is mainly responsible for cultivating forages; raising and managing livestock at 20 ha collective land; and selling its own milk and meat products. The profits were shared among the farmers based on their contributions of assets. In Bailang village, apart from managing the collective foraging-farming system, the cooperative also provided technical support of forage cultivation to villages in need. In Zhangmai village, the cooperatives served as platforms to connect farmers to teams of scientists, and companies that sell meat products.

(4) Training

CAS organized several training activities for the key staff of cooperatives in order to equip the locals with the knowledge and skills for managing the forage cultivation and intensive animal husbandry. The training topics included the technology and methods of machinery cultivation, packing of forage crops, and raising and management of intensive animal husbandry.

Description of the results

This project changed the villages in the aspects of economy, ecology, livelihood, human capacity etc. Meanwhile, these achievements of the project are helping locals to adapt to climate change. Following are the results of all three subprojects.

(1) *Improving livelihoods and food security:* By establishing three integrated farming-grazing systems, the project helped to increase agricultural productions therefore improve traditional livelihoods and the people's food security under climate change. In Bailang village, the productivity of grass and forage in restored grassland increased by three times. In Jina village, the productivity of meat and dairy products in integrated agriculture-grazing system increased by 30%. In Zhangmai village, the survival rate of Tibetan pigs increased by 10%. In 2015, although a severe drought hit the Bailang village, the produced forage was still able to meet the need of livestock due to the sufficient self-supplied forage.

(2) *Increasing financial capitals:* Apart from strengthening the income from the traditional livelihood, the project helped the locals generate income by building new alternative non-agricultural livelihoods. In Bailang village, after benefited from related training, young people in the cooperative were sent to provide technical support for the cultivation of forage in surrounding villages. These services now account for 60–70% of the income of the cooperative. Moreover, the cooperative helped to diversify households' livelihoods through collective forms such as meat processing. In this way, the profits from selling their products were received directly from the customers without sharing with intermediaries. At the end of 2014, in Zhangmai village, the profits from agricultural activities increased by 103%. On average, all households in these three villages had been helped to increase their income by more than 2,200 RMB (increased by more than 40%).

(3) *Enhancing social capitals by establishing new cooperatives:* Each of the three cooperatives involved more than 95% of households in their villages. Compared with companies outside of the community, local cooperatives manage their livelihoods better by integrating traditional local knowledge into the operation. Additionally, community-based cooperatives become important social connections or capitals for households which may buffer the impacts of climate change for locals. Cooperatives reduced the individuals' risk of raising sheep at the community level by buying the sheep from individuals. In addition, the cooperatives became a new place where people could borrow money from when in need. In Bailang village, cooperatives had already lent money to several villagers.

(4) *Capacity building*: During the project, more than 1,000 locals attended the training organized by CAS. In addition, eight core members in Jina village's cooperative participated in the special training for the management of cooperative and key technology of intensive animal husbandry.

(5) *Demonstration of integrated farming-grazing systems:* All three integrated systems and their related technologies were demonstrated to the public. The demonstrations were praised by Tibet Government and Central Government of China.

GOOD PRACTICE ANALYSIS*

Knowledge building

How has the project built upon or applied the findings of specific research projects? How has the project actively contributed to international understanding on Ecosystem-based Adaptation?

These projects were based on previous research on crop productivity and selection of seeds. From 2010, CAS have already conducted experiments in Tibet on the cultivation of a variety of seeds that were selected from Qinghai province. China Agricultural University, Nanjing Agricultural University, Tibet Academy of Agricultural and Animal Husbandry Sciences, and other research institutes support the technologies related to forage packing and animal husbandry. The technical support from the previous research and other research institutes enabled the transformation of ecosystem services to livelihoods. As a result, this project also developed three models of integrated farming-grazing systems.

Furthermore, this is an ecosystem-based adaptation project with a focus on agricultural practices. It developed four key lessons and experiences for EbA in agricultural area specifically, and adaptation generally, as described above. Although some specific techniques of grassland restoration may only be applicable in the context of Tibet or other similar environment, the experience of cooperatives and methods of ecosystem management, such as multiple cropping and integrated farming-grazing systems could be applied in a broader context.

Community participation and inclusiveness

Has the project consulted with local communities in the formulation, implementation and decision making process? How were gender issues incorporated? Explain how the project mobilized local interest and ownership in order to ensure its activities responded to the needs of local beneficiaries.

Locals have been involved in the decision-making process and implementation. CAS organized community meetings to consult the locals on several issues, ranging from the establishment of cooperatives, the methods of sharing profits made by the cooperatives, to ways of managing the cooperatives.

The project successfully attracted the locals for two main reasons. First, as CAS funded the project and got support from several research institutes, the risk and cost of applying new technology and models of livelihood were responsible by the project and CAS themselves. Therefore, without much risk to take, the locals were willing to engage in the project. Second, the cooperative started to gain profits from the following year of the initiation of the project. It attracted the last un-involved group to join the cooperative.

For the government, CAS designed the project in consideration of one of the goals of central government, which is to increase Tibetan's income. Motivated by political achievement, local government coordinated and supported the project.

* This analysis is based on the "principles of good practice" developed by the EU/FP7-funded project AfriCAN Climate (2011-2014). These principles represent critical cross cutting issues shared by the majority of climate change projects, regardless of focus, scope and scale. They are intended to encourage critical reflection and help project developers and decision-makers draw out relevant lessons. Source: http://africanclimate.net/en/good-practice/8-principles-good-practice

Political ownership, collaboration and approval

How has the project secured support from political-level stakeholders and aligned its activities with wider development agendas to trigger further collaboration opportunities?

The project ensured support from the government by setting goals that were compatible with national policies. First, this project is in response to the Twelfth Five-Year Plan for National Economic and Social Development of People's Republic of China, which is issued by the central government of China. In this plan, one of its goals is to alleviate poverty by 2020. CAS designed the projects as to help to achieve this goal in response to the request of Tibet central government. Thus, the project received support from all levels of government in Tibet. Second, the central government also enacted The Plan of Protection and Establishment of Ecological Barrier in Tibet (2008-2030), in which protection of natural grassland is one of the five key ecological programmes. The restoration of grassland in two subprojects was aligned with this plan.

Besides, based on this pilot project, CAS suggested further projects with an aim of increasing the benefits of agricultural and grazing area in Tibet. One suggested project has already been adopted, and incorporated into *Tibet's Thirteenth Five-Year Plan*.

Financial sustainability

How has the project secured financing for sustaining and/or expanding its impacts beyond the initial project lifetime? Explain how the project secured national (e.g. government) and international (e.g. international donors) support for sustaining its impacts.

Funding for further development has been attained from two sources: self-supplied cooperatives and following projects. First, every year CAS and the cooperatives encouraged the locals to invest part of their profits generated from the cooperative to maintain or enlarge its activities. For example, in 2014, every household invested 400 RMB out of the 1,000 RMB profits to the cooperative. In 2015, each household invested 800 RMB/2,000 RMB to the cooperative. The reinvestment ensured the sustainability of the cooperative and thus activities that generate profits. Second, the success of the project and report attracted subsequent support from government and research institutes. In Bailang villages, the institute 'Tibet Research Center for the Engineering and Technology of Alpine Grassland' approved three new research projects for CAS to study the ability to restore natural grassland and ecosystem services. The agricultural and grazing bureau of Gongga County funded another project to support further development of the cooperative in Bailang village.

Achieving co-benefits and balancing trade-offs

How were the costs and benefits external to the project taken into consideration, e.g. on employment, environment, health, poverty levels, food security etc? Explain how the project aimed to maximizing external co-benefits from project activities and avoid/minimizing external costs and damages.

There are several benefits beyond the achievements of the project. Apart from the benefits shown in the project results section above, the project also increased the job opportunities for the villages. People were hired to construct the infrastructure for animal husbandry, to work for forage cultivation and animal husbandry and to manage the cooperatives. Furthermore, this project also generated more than twenty graduate students who conducted the research under these subprojects. Outcome of the research contributed to the knowledge on ecosystem services. In addition, indirectly, livelihoods were diversified in Bailang village. The locals learned from the model of the established cooperative. As a result, they organized four more small cooperatives based on their expertise. These cooperatives focus on artificial flowers; forage processing; wool product and a local teahouse.

Moreover, the three subprojects were designed with the goal of enhancing both livelihoods and ecosystems at the same time. Also, various aspects of the social-ecological systems have been considered as to minimize the cost. For example, in Jina village, the project included leguminous plants in the second-round crops in order to maintain the fertility of the cropland. In Bailang village, the cooperative refused a big investment from individual investors in order to guarantee that profits shared by each household remain high. CAS also adjusted the management plan of degraded grassland as to balance the land productivity and carbon storage of the land. Additionally, in order to reduce the risk of the market of meat products, CAS planned for the cooperative in Jina to sell their products directly to restaurants, which are the end of the production chain.

Building local capacities

How has the project ensured that local capacity was built during implementation phase? Explain how training programmes were integrated into core project activities and the measures taken to assure that built human capacity is maintained beyond the project's lifetime.

Building local capacities to manage local livelihoods was a main part of the project. Firstly, CAS organized several training sessions for key staff of the cooperatives in order to increase their capacity to manage their livelihoods. Most of the training related to technology was organized at the cooperatives when experts visited the villages periodically. In addition, CAS sent two key technical support staff in Jina village into the cooperative to Changsha, Hunan Province, to receive systematic training of cow husbandry. In addition, the training given to the cooperative contributed to the local community in the long term. In Bailang village, the cooperative received extra income by sending young staff to instruct the villagers who wanted to learn the forage cultivation technologies. Secondly, the agricultural machines that CAS purchased during the project were left for these villages and thus would continue contributing to local's capacity of managing the ecosystems when the project is over.

The social capacity of local communities also increased as cooperatives played an important role in social linkages, providing livestock raising techniques, reducing risk of market price fluctuations for sheep raising, and providing loans. In this way, the cooperatives could buffer the communities from impacts of unexpected natural disasters and increase their opportunities for improving their well-being.

Transferability

How has the project ensured that its activities can be transferred beyond the specific contexts in which they were implemented? Explain how particular project measures, activities or concepts could be/have been applied in another contexts or regions and how successful these efforts have been.

One of the goals of the project is to demonstrate integrated farming-grazing systems that were built under the project. These pilot subprojects were designed and implemented in three typical types of villages in Tibet: villages relying on agriculture, on agriculture and grazing, and on agriculture and forestry. Based on these three pilot subprojects, government and CAS aimed to demonstrate three integrated farming-grazing systems and their related technologies to the whole of Tibet.

As a result, many of the products developed from the projects are transferable. First, these projects developed the formula and technology for forage cultivation and intensive animal husbandry in alpine ecosystems. These technologies may be applied to other areas of Tibet or even other cold regions with limited water resources and seasonal-concentrated precipitation. For example, Shigatse (one important city of forage cultivation in Tibet) has already incorporated the methodologies of forage cultivation from Bailang village into its own development plan. Also,

Heilongjiang Province has broadly applied the model of 'raising geese in corn farmland'. Furthermore, these projects also developed the model of community cooperatives based on the livelihoods. This could also be applied to other areas in Tibet or other villages that have community-wide characteristic agriculture or livelihoods that are based on similar resources.

Monitoring and Evaluation

How has the project demonstrated its impacts in terms of achieving objectives, outcomes, and outputs? Explain how M&E plans were developed, and how effectively they have been applied.

CAS has plans of monitoring and evaluation for both ecosystems and subprojects. For the grassland ecosystem, CAS monitored periodically on its growth, biomass and biodiversity and the productivity of forage. The results of monitoring were mainly used to support the research of CAS. For the project operation, the operational team stayed at the pilot sites for six to eight months every year in order to monitor the project and coordinate it. The team monitored the production of forage and livestock by interviewing the cooperatives, which are the main source to generate additional income for the households. These staff communicated with the cooperatives every week during their stay. For the evaluation of the project, CAS reported the work and results of project annually. In 2014 and 2016, CAS developed two detailed reports of evaluation for the project.

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