APFNet

Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

Demonstration of vegetation restoration and management and utilization of forest resources in the Greater Central Asia

(Chifeng site)

Final Report

[Project ID：**2017P1-INM**]

[Project Period：**2017.01-2019.12**]

Supervisory agency: Chifeng Forestry and Grassland Bureau
Executing agency: Aohan Sanyijing Forest Farm
Submission date：2019.11

Basic information on project implementation

Project Title	Demonstration of vegetation restoration and management and utilization of forest resources in Greater Asia(2017P1-INM)
Supervisoryagency/competent authority	Chifeng Forestry and Grassland Bureau
Implementing agency	Aohan Sanyijing Forest Farm
Implementing agency	-
Project approval date：09/2016	
Project duration: 01/01/2017 to 31/12/2019， 36 months	

Total budget（RMB）	5,133,600	APFNet approved amount （RMB）	3,450,000
Actual cost（USD）	699,840	APFNet actual appropriated （RMB）	3,042,623

APFNet funding appropriation	Appropriate date	amount（RMB）
To the forest farm account	2017.04.05	1,109,600
To the forest farm account	2017.06.28	388,840
To the forest farm account	2017.09.29	689,220
To the forest farm account	2018.04.28	60,000
To the forest farm account	2018.06.29	528,500
To the forest farm account	2019.10.14	266,463
Not request for appropriation yet		357,077

Project reporting	Implementing period	Progress status
1st report（01/2017—12/2017）	Jan. 2017 — Dec. 2017	Normal
2nd report（01/2018—12/2018）	Jan. 2018 — Dec. 2018	Normal
3rd report（01/2019—12/2019）	Jan. 2019 — Dec. 2019	Normal

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Project Implementation Summary

"Demonstration of vegetation restoration and management and utilization of forest resources in the Greater Central Asia (Chifeng site) (Project ID: 2017P1-INM)", funded by Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet)，takes Aohan Sanyijing Forest Farm as a pilot, aims at building a forestry demonstration zone with various advanced mature technologies to facilitate the regional vegetation recovery, to develop multi-functions and comprehensive benefits of forests, to ease and make responds to the global climate change, to combat desertification and improve ecological environment, to increase the living condition of farmers, and in the end to set typical examples of vegetation restoration and management and utilization of forest resource in similar regions of the Greater Central Asia. The project implementation duration is from January 2017 to December 2019. During the project implementation, some amendments were proposed and put into implementation under APFNet's approval.

An overall review for sandy land management of Chifeng is taken during the project implementation. Representative pilot demonstration areas for comprehensive sand prevention and control are selected in accordance with the basic factors of the type of sandy land, the technology of sand combating, the effectiveness of the management, and the duration of treatment. A "Research Report on Typical Models of Sand Prevention and Control in Chifeng" is finalized with the summary of sand control techniques and the refine of sand control models by means of the surveys on remote sensing technology, sandy vegetation, soil texture, biomass and wind speed. The afforestation technical models for sandy land vegetation restoration which are suitable for the region are built and regarded as demonstrations to provide theoretical basis and field cases for sand prevention and control in Greater Central Asia; Based on the climate and site condition of the project area, good sand-fixation species of strong resistance are selected, models of multi-species mixture and series technology of sand vegetation rapid restoration are adopted, to improve the stability of forest stand and the quality of sand ecosystem, to improve land using rate, to further increase forest output and economic benefits on the basis of achieving windbreak and sand fixation effects, thereby to promote the sustainable development of forest resources, and to provide technical support and demonstration for vegetation restoration and comprehensive rehabilitation of sand prevention and control in Greater Central Asia and similar regions; the technology of high-yield management for inefficient forest are taken based on the existing wild apricot resources in the forest farm, through which, the economic benefits are improved under ensuring ecological benefits, the sustainable management and utilization of wild apricot resources are realized. It also provides

demonstration and drive for the development of sand industry; in consideration of demonstration of vegetation restoration and management and utilization of forest resources, and focusing on improving the forest sustainable management capability of the forest farm, training courses are held, domestic and international study tours are organized, to broaden the view of the forest farm managing staff and technicians, to improve the management level of the forest farm; publicity on the project progress and stage results is made to expand the project influence, to increase the project reputation, and to achieve the expected demonstration effect; the monitoring and evaluation system is established to make comprehensive evaluation for the project progress and effectiveness, to provide a scientific basis for the smooth implementation and demonstration promotion of the project .

The project construction focuses on vegetation restoration, sand industry development and utilization, and sand prevention and control. The project activities relate to key technology urgently needed in the sand area. The selected plant materials are all dominant species with certain economic advantages. A referential management model is provided especially in the development of the sand industry, which is good to promote the positive circulating and the sustainable development of forest resources. A comprehensive sandy land rehabilitation demonstration base with functions of "sand prevention and control, vegetation restoration, resources utilization" is set up through the implementation of the project, which plays a significant role to improve regional ecological environment, to improve forest quality and efficiency, to promote regional economic development, and will play a good demonstration in the vegetation restoration and management and utilization of forest resources in Greater Central Asia.

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1. Background and introduction

1.1 Background of the project

With the acceleration of global economic integration, especially since the birth of the Silk Road Economic Belt initiative proposed by Chinese President Xi Jinping, the exchange and cooperation between China and the countries in Central Asia, including Mongolia Republic, is becoming increasingly active. The initiative has attracted high attention of international communities. The countries along the ancient Silk Road, especially which of the Central Asia in the Eurasia hinterland, also responds actively. It also painted a grand blueprint for the further in-depth cooperation between Countries in Europe and Asia in the new era. In 2015, Inner Mongolia was incorporated into the building scope of the Silk Road Economic Belt as one province of the 16 in "one belt one road" core region and also the top priority of the 6 Chinese provinces in Greater Central Asian.

In 2016, the Asia-Pacific Network for Sustainable Forest Management and Rehabilitation initiated the project of "Demonstration Project of Vegetation Restoration and Management and Utilization of Forest Resources in Greater Central Asia". The project aims at carrying out vegetation restoration, developing sand industry and building sand combating demonstration zones to improve the ecological environment of the project area, to increase the quality and efficiency of the forest, and in the end to set typical examples of vegetation restoration and management and utilization of forest resource in the Greater Central Asia. Aohan Banner locates on the south edge of Kerqin Sandy Land, and in the transition zone from Yanshan Mountains to Songliao Plain. The total land area is 83,000 hm2 with serious desertification and fragile ecological environment. Over the years, Aohan Banner has made great achievements in vegetation restoration, sand industry development and utilization, and sand prevention and control. It gains "the Global Top 500" Environment Award from the United Nations Environment Program, and the titles of "National Advanced Forestry Ecological Construction County" and "National Demonstration County to thrive forestry with Science and Technology" from State Forestry Administration. Relying on the key projects such as Land Reversion to Forest, Sand Source Control around Regions of Beijing and Tianjin, Sino-German Cooperation for Afforestation, and Japanese aided project, Aohan Sanyijing Forest makes full use of the own advantages and built 285.33hm2 of quality engineering, which greatly facilitate the construction of ecological environment of surrounding areas. The APTNet, After full field inspections, decided the Forest Farm as a project area in China.

The project area is in the Sanyijing Forest Farm (120°14′~120°22′E，42°30′~42°51′N) in southeast of Aohan Banner, Chifeng City, on the southern edge of Kerqin Sandy Land, adjacent to Xinwopu Village of Mutouyingzi Township in the east, to Gangyingzi Village of Mutouyingzi Township in the south, to Dongwanzi Village of Mutouyingzi Township in the west, to Sanyijing Village of Changsheng Town in the north. There is Jingtong Railway through the whole territory. The state-owned Sanyijing Forest Farm is 80km away from the site of Aohan Banner Government. The total area of the forest farm is 3,771.3hm2 at 15km long from east to west and 20km long from north to south. The selection conforms to the relevant conditions and requirements as a demonstration project of APFNet. The Forest Farm is in a typical windy sand area at the southern edge of Kerqin Sandy Land. The terrain is relatively flat with the elevation between 460-500m. It belongs to arid and semi-arid continental climate, dry with little rainfall of the year. The average annual temperature is about 7.0℃ with the extreme minimum at -29.7℃ and the extreme maximum at 39.9℃. The annual sunshine duration is 2,900 hours, the annual precipitation is 360mm, and the annual evaporation 2,400mm. The growth period is 143 days. The average wind speed is 3.5m/s, and the strong wind duration is about 40 days annually. Land desertification in this area makes it difficult to restore vegetation. The poor quality and low efficiency of the forest have seriously affected the production and life of the local people, and the development of the local economy. The main content of the project is vegetation restoration, sand industry development and utilization, and sand prevention and control. Through the implementation of the project, a comprehensive sandy land rehabilitation demonstration base with functions of "sand prevention and control, vegetation restoration, resources utilization" is set up, which plays a significant

role to improve regional ecological environment, to improve forest quality and efficiency, to promote regional economic development, and will play a good demonstration in the vegetation restoration and management and utilization of forest resources in Greater Central Asia.
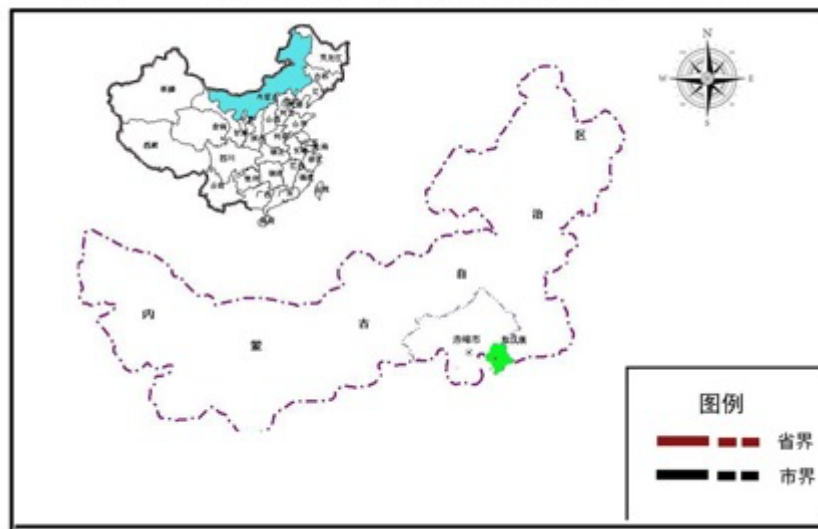
Figure 1 Location of Aohan Banner
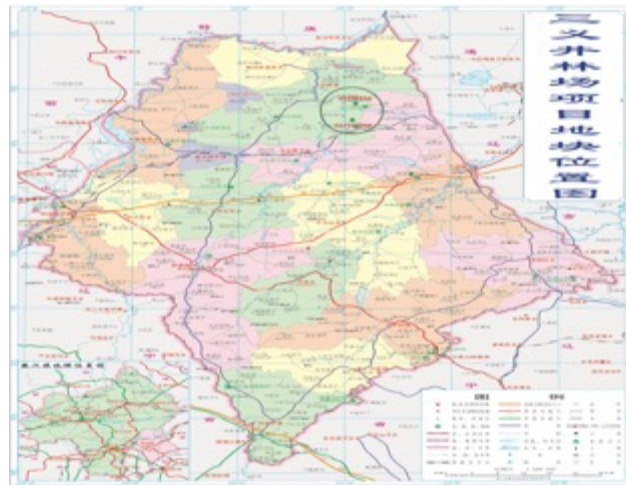
Fugure 2 Location of the Project Area

1.2 Objectives and tasks of the project

1.2.1the overall objectives

The project, taking sand control, vegetation restoration and sand industry as construction contents, by building demonstration zones with a collection of various advanced and mature technologies, commits to promote regional vegetation recovery, enlarge regional forest coverage, increase the quality of sandy land ecological system and the sustainable management, give full play to the multi-functional effects and comprehensive benefits of forests, ease and combat the global climate changes, effectively control desertification and improve ecological environment, increase the living standard of farmers, and to build typical models to vegetation restoration and management and utilization of forest resources in similar areas in Greater Central Asia.

The overall idea of the project design is shown in Figure 3.

1.2.2 the concrete objectives of the project

The concrete objectives of the project are as follows:

1. Compile "Research Report of Typical Models for Desertification Prevention and Control in Chifeng", give a full-scale summary to the typical models for desertification prevention and control in Chifeng and provide theoretical basis and physical cases for regions in Greater Central Asia.

2. Make demonstration on high-standard sandy-land vegetation restoration and afforestation technical models fitting for the local situation, improve forest stand quality and multifunctional benefits of forests.

3. Use the existing wild apricot to make demonstration of high-yield management technology to low-efficiency forests, and also give consideration to ecological and

economic benefits, to provide demonstration and leading role for development of sand industry.

4. Combining with demonstration conducted by the project for vegetation restoration and management and utilization of forest resources and through holding training courses, carry out domestic and international exchange, broaden perspective of managing staff and technical staff in the forest farm, improve management levels of the forest farm.

5. Through publicity of project progress and stage achievements, expand the influence of the project, increase the popularity of the project, and achieve the expected results.

6. Through establishment of monitoring and evaluation system, perform comprehensive appraisal to project progress and effectiveness, provide scientific basis for the smooth implementation of the project and demonstration and extension of the project.

1.3 Estimated output and results

1.3.1 compile "Research Report of Typical Models for Desertification Prevention and Control in Chifeng";

1.3.2 build 70 hm^2 vegetation restoration demonstration forest on sandy area;

1.3.3 build 39 hm^2 of economic forest demonstration base in sandy area;

1.3.4 Capacity building：train for 500 persons, domestic and international exchange for 20 persons, compile a project training technical manual.

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│ Demonstration of vegetation restoration and management and          │
│ utilization of forest resources in the Greater Central Asia         │
│ (Chifeng site)                                                       │
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| Investigation of sand control models | build vegetation restoration demonstration forest | build economic forest demonstration base | Capacity building of forest farm |

| Investigation and research plan of typical models and control in Chifeng | build mixed demon. forest with Mongo. pine and Xinjiang poplar | build mixed demon. forest with Mongo. pine and yellow-horn | demon. forest of Prunus. grafting techno. on wild apricot | demon forest of wild apricot high-yield mana. tech. | Demon. forest of Prunus. high-yield mana. Tech. | tech train-ing | com-pile tech ma-nual | Pub-li-city |

| provide theoretical basis and physical cases for regions in Greater Central Asia | improve forest stand quality and multifunctional benefits of forests | provide demonstration and leading role sand for development of industry | broaden perspective of managing staff and technical staff of forest farm, improve their management levels |

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│ Build a comprehensive sand control demonstration base with          │
│ functions of "sand prevention and control, vegetation restoration,  │
│ resources utilization", and build a typical demonstration in the    │
│ vegetation restoration and management and utilization of forest     │
│ resources in Greater Central Asia.                                  │
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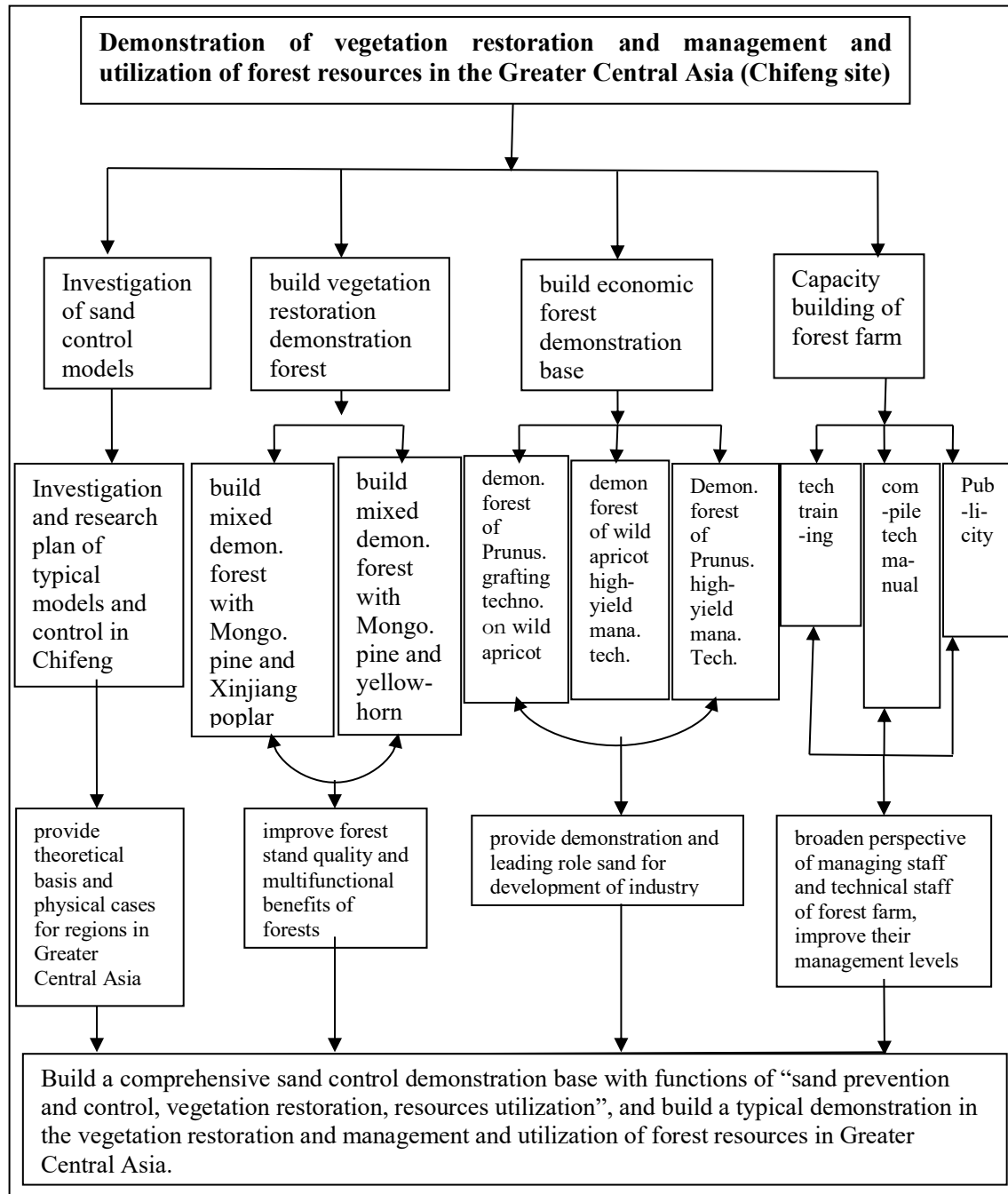
Figure 3   The overall idea of the project design

2. Implementation

2.1 Project schedule and implementation arrangement

The project implementation generally went smoothly.

Since the project started up in 2017 in Sanyijing Forest Farm of Aohan Banner, Forestry Chifeng Forestry Scientific Research Institute compiled "Investigation and Study Plan of

Typical Models for Sand Prevention and Control in Chifeng", and completed the planning for afforestation site-preparation and ditch-opening; The forest farm built 70 hm^2 demonstration forest of vegetation restoration in sandy area, including 30 hm^2 demonstration forest mixed with Mongolian pine (*P.sylvestris L. var.mongolica Litv*) and Xinjiang poplar (*P.alba L. var.pyramidalis Bge*), and 40 hm2 demonstration forest mixed with Mongolian pine (*P.sylvestris L. var.mongolica Litv*) and shiny-leaved yellowhorn (*Xanthoceras sorbifoLia Bunge*), and all with the monitored survival rate over 90%; built 39 hm2 demonstration base of cash trees in sandy area, including 8 hm^2 Prunus Armenia (*Armeniaca vulgaris × sibiric*) shaping and pruning, 18 hm2 wild apricot (*Armeniaca sibirica (L.) Lam*) trees shaping and pruning, and 13 hm2 Prunus armeniaca grafting on wild apricot, and all with monitored grafting survival rate over 95%; In early March, the forest farm organized training courses, field demonstration and technical guidance for totally 50 trainees on technique *Prunus armeniaca* grafting on wild apricot, and organized training on afforestation technology of Mongolian pine, Xinjiang Poplar and shiny-leaved yellowhorn for 50 technicians and managing staff.

In 2018, Chifeng Forestry Research Institute conducted a survey and research on the demonstration area for comprehensive sand control in Chifeng based on the "Investigation and Research Plan for Typical Models of sand Control in Chifeng", and 22 sample plots were identified after the field survey and indoor analysis; in May, the project applied for amendment to take a trial of 40 mu under-forest economic planting model in forest of Mongolian pines and Xinjiang poplars, planting 20 mu liquorice and 20 mu perennial flowers (5 mu of safflower Sedum, 5 mu of *Sedum sarmentosum,* 5 mu of *Hemerocallis hybrida*, 5 mu of *Hemerocallis fulva* 'Golden Doll'; the forest farm completed work of tending and managing of 70 hm^2 demonstration forest of vegetation restoration in sandy area and 39 hm^2 demonstration base of cash trees in sandy area; the monitoring work required for the project activities has been completed, and all indicators have reached the designed standard, and a monitoring report has been compiled. Besides, the forest farm held training courses for 200 trainees on vegetation recovery and management and utilization of forest resources, on technique of Prunus Armenia and wild apricot pruning, technique of Prunus armeniaca grafting on wild apricot, and afforestation technology of Mongolian pine, Xinjiang Poplar and shiny-leaved yellowhorn; the forest farm compiled a project technical training manual, made a set project PPT and a set of video project publicity film. In the course of the project implementation, each output activity is taken pictures and videos to reserve as data; some were publicized in medias including Aohan Banner Government Website, China Green Times, Chifeng Hongshan Evening News, Chifeng Daily, Green Chifeng Website, Inner Mongolian Forestry Website.

In 2019, the research team of Chifeng Forestry Research Institute, in response to the needs of "Report on Typical Models of sand Control in Chifeng", carried out data collection and analysis, set up additionally 13 sample plots and conducted surveys, measured land surface wind speed and sand collection. There are initially identified 10 types of sand control technologies (sand closing for enrichment, dibble seeding by belt or line, biological sand barrier, degradable fiber sand bag, physical sand barrier, mixed forest, pure forest, gauze sand barrier, planting seedlings, and integrated rehabilitation (fencing, aerial seeding

and dibble seeding)), which are related to sandy vegetation sustainable management technology, artificial afforestation for sand control technology, grass closure construction, aerial seeding technology and their corresponding comparison plots. And later on with the data collection,discussion and refining, the technologies are adjusted technologies as follows, namely, the establishment of physical sand barrier, the establishment of biological (composite) sand barriers, enclosure, artificial seeding for restoration, artificial planting for restoration, aerial seeding for restoration, artificial afforestation for sand control, grass closure technology in sandy land, 5 model out of which are determined, namely, setup of physical sand barrier for sand control, setup of composite sand barrier for sand control, artificial promotion for restoration under   closure, artificial afforestation for sand control, and sustainable management of sandy vegetation. The compilation of "Brochure for typical models of sand prevention and control in Chifeng" in Chinese and English versions and the compilation of "Report on Typical Models of sand Control in Chifeng" are completed. We Participated the International Training Course on "Integrated Desertification Management in Greater Central Asia" and the branch annual meeting of 14th Inner Mongolia Autonomous Region Natural Science Academic Conference and Forestry Associations Joint Meeting of the Five-Province of North China. The forest farm manages 70 hm^2 demonstration forest of vegetation restoration in sandy area: water once in April, weed once between planted trees in June: weeding width require for 1.5m and 75cm long to each side of the tree; carry out guarding work. The investigation shows that the afforestation preservation rate is more than 90% with good growth. The forest farm manages 39 hm^2 demonstration base of cash trees in sandy area: weed in June, require no weeds in the tree trays and no weeds between trees and lines, and carry out guarding measures covering ① prevention and control of *Melacosoma neustria testacea Motschulsky* and other pests and diseases in April. ②Fire control strictly in accordance with fire management requirements. ③Strengthened guarding of project area. The forest stand grows well which have achieved the expected goals. A training course was held once in March. Relevant experts were invited to give lectures on afforestation technology and wild apricot management for 50 forest farm technicians and 50 workers. A technical manual was compiled and printed for 100 copies. Monitoring was organized and the monitoring report was compiled. The views of the forest farm staff were broaden through domestic study tour exchanges. From July to August, a domestic study tour exchange was organized for the forest farm staff and the project office staff: visited typical sand control unit of Chifeng, Inner Mongolia Desert Flower Ecological Industry Technology Co., Ltd, Huangyangwa Yellowhorn Industry Construction Base, sand control demonstration base with Mongolian pine of Changsheng Zhisha Forest Farm. Collection of all kinds of materials, pictures, videos are made during every stage of the project implementation to compile brochures in Chinese and English versions. Propaganda reports on the staged results of the project were made through internet, media, publication, visitiing demonstration bases and training, to expand the influence of the project and to increase the reputation of the project. Thematic seminars were held, thematic reports were composed and thematic project film was produced.
The reason for unfinished international study and exchange is the failure to rationalize the schedule.

2.2 Project resources and expenses

2.2.1Project executing unit

The budget for the project is RMB 5,133,600 (converted into USD 744,000 at an exchange rate USD 1 = RMB 6.90), out of which, RMB 3,450,000 (USD 500,000) is financed from APFNet, and RMB 1,683,300 (USD 244,000) is from the local finance and the Forest Farm in form of cash counterpart.

In 2018, the newly added counterpart funds of RMB 247,800 was input due to the added trial of the under-forest planting model, the channel of which is from Chifeng Forestry and Grassland Bureau through matching with the sand source control project around Beijing and Tianjin, the establishment of the economic forest, the forest farms self-raised funds and the labor input of the forest farm workers.

A total transferred funds is RMB 4.555223 million, Among which, RMB 3.042623 million is from the APFNet, RMB 900,000 is from Chifeng Forestry and Grassland Bureau, RMB 410,000 is from matching with the sand source control project, and RMB 200,000 is from matching with the establishment of economic forest.

The total expenditure was RMB 4.828901 million, Among which, RMB 2.293963 million is funds of the APFNet, RMB 900,000 is the counterpart funds of Chifeng Forestry and Grassland Bureau, RMB 410,000 is the matching of the forest farm sand source project, RMB 200,000 is the matching of the establishment of the economic forest, RMB 25,900 is fund self-raised by the forest farm, RMB 384,938 is the unpaid engineering cost.

2.2.2Funds management

The project funds application and management will be under the basic principles and general requirements of APFNet on the application of project funds, and with consideration of the financial management system established by the implementing agency, to secure the safe and efficient use of project funds. There should be a specific account for for project funds for fixed purpose only. Project output activities can be only paid after check and acceptance with reimbursement vouchers on review of financial section and signature of head of the project office. The payment pattern shall be in cheque or in remittance only.

All project budget funds are used for the project construction, and none of use for other purpose except some cross-use between individual activities, concretely: (1) the remaining fund in 2017 is RMB 73,800, among which, RMB 28,000 used for domestic study and exchange, RMB 26,900 used as the contingency cost, and RMB 18,900 used for the beating-up; (2) the remaining fund in 2018 is RMB 376,700, among which, RMB 280,000 used for the international study exchange, RMB 26,900 used as the contingency cost, and RMB 11,800 used for the domestic study exchange. The amount of the both items is a total of RMB 392,500.

2.3 Monitoring, evaluation and report

According to the actual demands of the project, and to ensure that the project demonstration and training activities can effectively achieve the expected outputs, Chifeng Forestry and Grassland Bureau and Sanyijing Forest Farm employ the local experts to provide technical support for the project implementation. Chifeng Forestry Scientific Research Institute, commissioned by Chifeng Forestry Foreign Cooperation Project Work Station, conduct comprehensive monitoring for the construction of Sanyijing Forest Farm project in Aohan Banner, to ensure the overall project construction meets the requirements of the project.

2.3.1 Compilation of "Research Report on Typical Models of sand Control in Chifeng"

Under the commission by the project executing agency and the project managing agency, in 2017 Chifeng Forestry Scientific Research Institute compiled "Investigation and Study Plan of Typical Models for Sand Prevention and Control in Chifeng". And on this basis, the Institute carried out this work in April 2018. In accordance with the demand of the project output, a comprehensive monitoring was conducted to the complication of "Investigation and Research Plan for the Typical Model of sand Control in Chifeng" , the setup of the permanent and temporary sample plots, field surveys, and data collection. For details, please refer to the attached the annual "Monitoring Report on Project Construction in Sanyijing Forest Farm of Aohan Banner in Chifeng".

Aiming at the two sandy lands of Kerqin and Hunshandake in Chifeng, we make a overall review over the comprehensive sand control demonstration areas, and determine Alukerqin Banner, Balinyou Banner, Wengniute Banner, Aohan Banner, and Kashike Teng Banner as comprehensive sand control pilot demonstration areas. Based on the basic factors such as sand type, sand control technology, treatment effectiveness, and treatment duration, we selected 35 representative demonstration areas and the comparison sample plots,which cover the representative sand control models in Chifeng. We then conducted work of data collection, outdoor field survey and indoor analysis, we collected   the samples and data of factors of soil, sand vegetation changes, vegetation coverage (canopy density), sand moving status, soil (sand) loss rate or sedimentation rate, Biomass, etc. We compiled "Brochure for Typical Models of Sand Prevention and Control in Chifeng", relevant training courses and papers, and " Study Report on Typical Models of Sand Prevention and Control in Chifeng".

2.3.2 Demonstration forest of vegetation restoration in sandy area

The forest farm constructed 70 hm^2 demonstration forest of vegetation restoration in sandy area in 2017, including 30 hm^2 demonstration forest mixed with Mongolian pine and Xinjiang poplar, and 40 hm^2 demonstration forest mixed with Mongolian pine and shiny-leaved yellowhorn.

In 2017, monitoring was conducted to afforestation area, afforestation quality (site preparation, seedling specification, planting, mixture ratio), monitoring to tending and guarding (on if to weed, if to water, if to apply fertilizer, on pest and disease control, fire control), monitoring to plant density, monitoring to survival rate, etc. The designed area of

the demonstration forest mixed with Mongolian pine and shiny-leaved yellowhorn (sub-compartment 1) is 40 hm^2 (600 mu), the verified area after monitoring is 40 hm^2 (600 mu). The quality site preparation is high. The status of seedling specification, planting, and guarding is good. The row spacing and plant density meet the designed requirements. The survival rate is 92% with good growth; The designed area of the demonstration forest mixed with Mongolian pine and Xinjiang poplar (sub-compartment 2) is 30 hm^2 (450 mu), the verified area after monitoring is 30 hm^2 (450 mu). The quality site preparation is high. The status of seedling specification, planting, and guarding is good. The row spacing and plant density meet the designed requirements. The survival rate is 94% with good growth. But lack of timely weeding in some sites. For details, please refer to the attached the annual "Monitoring Report on Project Construction in Sanyijing Forest Farm of Aohan Banner in Chifeng".

In spring 2018, beating-up was done in the demonstration forest for vegetation restoration in the sandy area. Tending and guarding were done throughout the year. The monitoring focued on: the quality of beating-up (site preparation, specifications of the seedlings, quality of replanting); the tending and the guarding (weeding, watering, fertilizer applying, pest and disease prevention, fire control and guarding); the survival rate; the survey of the growth and the evaluation of benefits. As for Sub-compartment 1 (the demonstration forest mixed with Mongolian pine and shiny-leaved yellowhorn), which   is 40 hm^2 (600 mu), beating up was done in spring 2018 with 2,194 qualified seedlings of yellowhorn and 278 qualified seedlings of Mongolian pine. The monitoring shows that the seedling specification used for beating-up is good quality, the situation of planting, watering and guarding is good, the row spacing and plant density meet the design, the survival rate is 93% with good growth; As for Sub-compartment 2 (demonstration forest mixed with Mongolian pine and Xinjiang poplar), which is 30 hm^2 (450 mu), the monitoring shows that the seedling specification used for beating-up, the planting, watering and guarding is good, the row spacing and plant density meet the design, the survival rate is 92% with good growth; but lack of timely weeding in some sites. As for the tending status, average growth, crown width, and two afforestation plots with the same site conditions and stand factors in the vicinity, the monitoring team selected 2 sites near the forest farm with the same site condition and forest stand factors to survey the growth and the evaluation of benefits. For details, please refer to the attached the annual "Monitoring Report on Project Construction in Sanyijing Forest Farm of Aohan Banner in Chifeng".

2.3.3 Monitoring of demonstration base of cash trees in sandy area

The forest farm constructed 39 hm2 demonstration base of cash trees in sandy area in 2017, including 8 hm^2 Prunus Armenia demonstration of high-yield management, 13 hm^2 Prunus armeniaca grafting on wild apricot, and 18 hm^2 wild apricot trees demonstration of high-yield management.

In 2017, monitoring was conducted to afforestation area, afforestation quality (site preparation, seedling specification, planting, mixture ratio), monitoring to tending and guarding (on if to weed, if to water, if to apply fertilizer, on pest and disease control, fire

control), monitoring to plant density, monitoring to survival rate, etc. The designed area of sub-compartment 3 is 8 hm^2 (120 mu), the verified area after monitoring is 8 hm^2 (120 mu). The quality site preparation is high. The tree shape pruning and tree management are fine. Watering, fertilizer applying and weeding meet the design. And guarding is good;   The designed area of sub-compartment 4 is 13 hm^2 (195 mu), the verified area after monitoring is 13 hm^2 (195 mu). The quality site preparation is high. The tree shape pruning and tree management are fine. The specification of seedlings is good quality. Watering, fertilizer applying and weeding meet the design. And guarding is good; The designed area of sub-compartment 5 is 18 hm^2 (270 mu), the verified area after monitoring is 18 hm^2 (270 mu). The quality site preparation is high. The tree shape pruning and tree management are fine. Watering and fertilizer applying meet the design. And guarding is good; But lack of timely weeding in some sites. For details, please refer to the attached the annual "Monitoring Report on Project Construction in Sanyijing Forest Farm of Aohan Banner in Chifeng".

In spring 2018, the monitoring on quality (species and quality of Prunus Armenia, grafting and pruning, and tree body management), on tending and guarding (remove of new sprouts, weeding, watering, fertilizer applying, pest and disease prevention, fire control and guarding), on the survival rate of grafting, the survey of the growth of wild apricot and Prunus Armenia, and the evaluation of benefits. As for Sub-compartment 3, which is 8 hm^2 (120 mu), the monitoring shows that the site preparation is good quality. The tree body management are fine. Watering, fertilizer applying and weeding meet the design. And guarding is good; As for sub-compartment 4 which is 13 hm^2 (195 mu), the quality site preparation is high. The tree shape pruning and tree management are fine.   Watering, fertilizer applying and weeding meet the design. Guarding is good. The survival rate of grafting is good; As for sub-compartment 5 which is 18 hm^2 (270 mu), the quality site preparation is high. The tree shape pruning and tree management are fine. Watering and fertilizer applying meet the design. Guarding is good, but lack of timely weeding in some sites, and slight pest and disease found in some sites. And the growth and yield effects are made. For details, please refer to the attached the annual "Monitoring Report on Project Construction in Sanyijing Forest Farm of Aohan Banner in Chifeng".

2.3.4 Monitoring for under-forest economy

In May 2018, the forest farm conducted the trial of under-forest economic growing in 2 sub-compartments of the demonstration forests (mixed forest of Mongolian pine and Xinjiang popular). The area for the under-forest growing is 40 mu, 20 mu of which to grow licorice, the left 20 mu to grow perennial flowers, including 5 mu *Rhodiola Rosea*, 5 mu *Sedum sarmenfosum Bunge*, 5 mu Red Hemerocailis, 5 mu Jinwawa Hemerocailis. The growth is good with good construction effects. For details, please refer to the attached the annual "Monitoring Report on Project Construction in Sanyijing Forest Farm of Aohan Banner in Chifeng".

2.4 Publicity and Knowledge sharing

1. In the course of the project implementation, each output activity is taken pictures

Figure 4　　Project start-up

Figure 5　　Report by Chifeng Daily

and videos to reserve as data; the project held the project start-up meeting which has been publicized in medias of Aohan Banner Government Website, Hongshan Evenings of Chifeng, Chifeng Daily, Green Chifeng Website, Inner Mongolian Forestry Website and the magazine of Inner Mongolian Forestry.

2. In the course of the project implementation, each output activity is taken pictures and videos to reserve as data, publicity reports are published in medias of Aohan Banner Government Website, Green Chifeng Website, Inner Mongolian Forestry Website and China Green Times.

Figure 6 Domestic exchange

Figure 7 site visit

3 In July 2018, the "Workshop on forest recovery and achievements and experiences exchange meeting from APFNet project in China" was held, and a field visit and study was organized, all of which is highly respected and widely accepted by the leaders and experts attending the meeting.

| Figure 8 Exchange on the site | Figure 9 Idea exchange meeting |

4 In 2018, International Training Course on Integrated Desertification Management and Livelihood Guarantee in Greater Central Asia was held. The project staff participated the academic exchanges.

5 Project experts and forest farm project staff summarized the results and experience obtained during the project implementation process, and co-authored and published two academic papers and research reports.

3. Performance of project participants

3.1 Performance of project supervision agencies

The project steering committee composes with members from Chifeng Forestry and Grassland Bureau, Aohan Banner Forestry and Grassland Bureau, leaders of other relevant agencies, and experts, responsible for leading, coordinating and supervising of the project implementation, coordinating counterpart funds, formulating and implementing relevant policies and measures, relieving any alteration of the project, studying and solving great problems dring the project implementation, reviewing annual performance and the work plan for the next year. securing the smooth implementation of the project. To ensure the smooth implementation of the project, an office is set up under the committee in specific charge of the following tasks:

1. Responsible for the the project work of guidance, supervision and evaluation under the guidance of the project steering committee.

2. Coordinate the appointment of experts and technical service work according to project progress and technical requirements.

3. Coordinate the implementation of the policies and measures and work deployment of the project steering committee.

4. Coordinate the project executing agency, the project technical support partner, the project experts, etc. to hold a project coordination meeting each quarter to review the completion of project work.

5. Undertake daily work and other duties of the project steering committee.

6. Make reasonable recommendations to the project steering committee based on the project progress.

3.2 Performance of project executing agency

The project executing agency has the responsibility to strengthen the organization and management, investment in science and technology, demonstration and promotion and use of funds, to successfully complete the tasks specified in the project according to the requirements of the overall plan and annual plan of the project.

1. Strengthen the organizational and leadership, and enrich management power. Since the project was started up, and according to the minutes of the project steering committee meeting, the office of the project steering committee was set up in Chifeng Forestry and Grassland Bureau, to ensure the smooth communication and effective coordination between all parties of the project with its rich international project management experience in project guidance, supervision and management. The project implementing office was established in Sanyijing Forest Farm, chief with the head of the forest farm, the deputy head of the forest farm as the executing chief, and 4 technicians assigned to take charge of this work. The project activity plans and schedules were formulated to ensure the smooth development of project activities.

2. Strengthen scientific and technical support and innovate working methods. The technical support team is composed of the technical experts in desertification control and forest management from Chifeng Forestry Scientific Research Institute, to provide technical guidance to the key technical problems of the project, the use of new technologies and new materials in the implementation of the project.

3. Strict fund management to improve use efficiency. The special account was opened for the funds in a separate account as a closed circulation to ensure the safe use of project funds. When a project activity completes and passes the acceptance, an application should be presented by the concrete implementer, after the reviewing by the project executing chief and the approval by the project management office director, the payment can be reimbursed. The project construction is taken as the first priority of the forest farm. The timely implementation of the project activities are secured even with advance funds When the project funds cannot be provided in time.

3.3 Performance of the implementing agency, advisers, contractors and suppliers

The project management office is set up responsible for organizing and coordinating the implementation of project activities, annual implementation, mid-term evaluation, final evaluation, and financial reporting. The project management office has a director mainly responsible for the operation and management of the project; two deputy directors mainly responsible for communication and coordination between different levels, and submit relevant materials and summary reports according to the requirements of the APFNet; 4 staff responsible for financial management, project publicity, logistics support and other related work.

The scientific and technical support expert team of the project is composed of technical experts engaged in desertification control and forest management in the Chifeng Forestry Research Institute, providing technical support for the implementation plan, key technical problems and the use of new technologies and materials in the project

The technical support team is composed of the technical experts in desertification control and forest management from Chifeng Forestry Scientific Research Institute, to provide technical support to the project implementing planning, key technical problems, the application of new technologies and new materials. The expert team participates all the steps of the project construction, to assist the preparation of the annual plan, various training materials and publicity manuals, and to proposes rational suggestions in a technical view to ensure the project construction matching with the expected objectives.

3.4 Functions of the APFNet

1. Project implementation has always been strongly supported by APFNet. At least one coordination meeting is held by the APFNet per year, to organize management of the project, to review project annual plan, and to make amendment and supplement to the project activities according to the actual situation.

2. A staff is appointed by the APFNet to communicate with the project, who comes to the project implementing agency for many times to give guidance and follow up the project progress; who coordinated China Green Times for a thematic report, and organized a visit of the ministers from the member countries of the "Asia-Pacific Forest Restoration and Sustainable Management Organization" to the forest farms, which improves the impact and the reputation of the forest farms and the project.

4.Performance of the project

4.1 Achievements

The 3 years' implementation of the project achieved obvious effects and the expected goals, which improved the quality of forest farm managing staff, and the management concept of the forest farm has been reversed. With the implementation of the project, a comprehensive sandy land demonstration base integrating "sand prevention and control, vegetation restoration and resource utilization" is built, which plays a significant role in improving the regional ecological environment, improving the quality and efficiency of forests, and promoting regional economic development, and will be a good demonstration in the vegetation restoration and forest resource management and utilization in regions of the Greater Central Asia. The project completes the tasks of designed bu the project and has reached its objectives.

4.1.1 Models for sand prevention and control in Chifeng

There are two sandy lands in Chifeng, which are Hunshandak Sandy Land and Korqin Sandy Land. According to the fifth national monitoring data of desertification and sandy land in 2014, the area of desertified land in Chifeng is 1.887 million hm^2, the area of Kerqin Sandy Land is 1.273 million hm^2 and the area of Hunshandak Sandy Land is 614,000 hm^2.

And an area of 967,000 hm^2 is of obvious tendency to desertification. Since the launch of the Project Sandstorm Source Control around Beijing-Tianjin in 2000, the sand prevention and control work has been carried outl in a large-scale. From 2000 to 2016, a total of 1.509 million hm^2 of the project has been done with obvious achievements.

From April to October 2017, Chifeng Forestry Scientific Research Institute conducted study on the sand control technology and the demonstration in Chifeng; in 2018, conducted investigation on the two sandy Lands through consultation and on-the-spot investigation, and over which made a comprehensive review; Some types have been eliminated based on basic factors such as sandy land type, sand control technology, treatment effectiveness, and treatment duration. Some of categories are eliminated according to sand type, sand control technology, rehabilitation effects and rehabilitation duration. 22 sample plots were initially selected from the representative demonstration zones for comprehensive sand prevention and control, which mainly distribute in Wengniute Banner, Aohan Banner, Balinyou Banner, Alukerqin Banner and Keshketeng Banner. Based on the collected data, 10 types of sand control technology are summarized, namely, the technology of mechanical sand barrier with biological measures, the technology of degradable fiber sand bag with biological measures, the technology of biological sand barrier (composite sand barrier), the technology of closure with natural recovery, the technology of closure with artificial seeding for recovery, the technology of closure with artificial planting seedling for recovery, the technology of artificial afforestation by belt, the technology of artificial afforestation by net, the technology of artificial afforestation by sheet, the technology of sandy plant sustainable management and utilization.

In 2019, another 13 sample plots were newly established after on-the-spot visit, surveys, consultations and survey statistics based on the basic factors of sand type, desert control technology, treatment effectiveness and treatment duration. Thus there are totally 35 representative sand prevention and control demonstration areas, with summarizing the statistics analysis which are summed up as the following technologies: the technology of mechanical sand barrier establishment, the technology of degradable fiber sand bag with biological measures, the technology of biological sand barrier (composite sand barrier) establishment, the technology of closure with natural recovery, the technology of closure with artificial seeding for recovery, the technology of closure with artificial planting seedling for recovery, the technology of aerial seeding for recovery, the technology of artificial afforestation for sand control, the technology of grass closure in sandy land, the technology of sandy plant sustainable management; for the 5 sand control models please refer to "Study Report on Typical Models of Sand Prevention and Control in Chifeng":

(1) For the model of mechanical sand barrier, the materials can be various on the local resources, no need for any processing, and low cost, such as grass, branches, clay, sandy gravel etc. The purpose is to increase the roughness of the surface, change the acting force of wind and the landform, to achieve the results for windbreak and sand stop, vegetation restoration and environment.

(2) The model of composite sand barrier can be used to rehabilitate mobile dunes in arid and semi-arid area. Shrub species should be selected of good germination, high economic value, strong regeneration ability, and easy to form the plant regeneration sand barrier. This model can fulfill the function of stop sand moving and wind erosion in a short time, but also fulfill natural regeneration, avoid from rebuilding every few years of the ordinary

barrier. The species selected can be used either as forage or industrial raw material. This is a renewable, sustainable, economic and practical model for sand combating.

(3) Restoration model with enrichment on basis of closure is one of the important measures for ecological construction by manual seeding or planting after closure to cultivate the trees, shrub and grass. It can facilitate more stable forest ecological system than the pure artificial plantation. It has become an effective method in sand area to cultivate forest.

(4) Sand combating model by artificial plantation should be applied to plant trees, shrub and grass on the sandy land, making maximal use of the natural resources of light, heat and water in consideration with the features of strong wind, dry climate and poor soil, and the practical problem of poor afforestation survival on the sandy land, artificial plantation technology. The establishment can fulfill the function of windbreak and sand-fixation, but also has the capacity of fast-grow, high-yield and good quality.

(5) The sustainable management model of sand vegetation. After the establishment the sandy vegetation community and keeping relatively stable, according to the biological and ecological characteristics of main species, the methods of cutting, level cutting for rejuvenation, transformation for quality improvement and reforestation are taken under the premise of no damage to the ecological benefits. It is a good method to make good use of the sandy vegetation, and also to make the vegetation group keep exuberant vitality, thus to realize the sustainable management.

Figure10 model of mechanical sand barrier   **Figure 11 model of artificial afforestation**

Figure 12 Model of composite sand barrier   **Figure13 model of closure for artificial enrichment**

Figure 14 model of sand vegetation sustainable management

4.1.2 Building of demonstration forest for vegetation recovery in sandy area

Over years Sanyijing Forest Farm has used poplar, the indigenous tree species, as the main afforestation tree, resulting in a single afforestation model and a single forest form. In

recent years, the global climate change causes the continuous drought, frequent occurrence of pests and diseases. A large-scale degradation or even death of shelter belts in the project area has occurred. According to the climatic type and site condition of the project area, models with multi-species configuration and series of technology for rapid vegetation

restoration are applied to by selecting sand fixation tree species with strong

Figure 15 effect of vegetation recovery in sandy land

resistance, to facilitate the improvement of the stability of the forest stand and the quality of the sandy ecosystem, which is beneficial to increase the land utilization, to further increase forest output and economic benefits when achieving effects for windbreak and sand fixation, by this way to promote the sustainable development of forest resources, and to provide advanced technical support and demonstration for vegetation restoration and comprehensive rehabilitation of sand prevention and control in the similar region of the Greater Central Asia.

The forest farm constructed 70 hm^2 demonstration forest of vegetation restoration in sandy area in 2017, including 30 hm^2 demonstration forest mixed with Mongolian pine and Xinjiang poplar, and 40 hm^2 demonstration forest mixed with Mongolian pine and shiny-leaved yellowhorn.

| Figure 16   Planting on the site | Figure 17   film mulching |

4.1.2.1 Building of demonstration forest mixed with Mongolian pine and Xinjiang poplar

The selected dominant tree species is Mongolian pine (4-year container seedling, height ≥1m) and Xinjiang poplar (seedling height≥2.5m, DBH≥2cm) by plot mixture, Xinjiang poplar planted as shelter belt and Mongolian pine within the belt, forming the wind-break and sand-fixation forest in shape of "belt, net and sheet". The site preparation is done by machine. Some drought-resistant afforestation technologies are applied, such as seedling soaking, application of rooting powder, watering before planting, set-up drought-resistant piles, and film mulching; regular field management and forest guarding are conducted; the survival rate is 94%.

4.1.2.2 Building of demonstration forest mixed with Mongolian pine and yellowhorn

Figure 18 Results after planting

Figure 19   Monitoring

The selected dominant tree species is Mongolian pine (seedling 4-year container, height ≥1m) and shiny-leaved yellowhorn (seedling height≥1.2m, ground diameter≥2cm) by 200m X200m plot mixture, Mongolian pine planted as shelter belt and shiny-leaved yellowhorn within the belt, forming the wind-break and sand-fixation forest in shape of "belt, net and sheet". The site preparation is done by machine. Some drought-resistant afforestation technologies are applied, such as set-up drought-resistant piles, and film mulching; regular field management and forest guarding are conducted; the survival rate is 92%; it is beneficial to increase the land utilization, to further increase forest output and economic benefits when achieving effects for windbreak and sand fixation; the developing mode of forestry is changed, farmers' income increased. It also provide demonstration for sand control in the similar regions.

4.1.2.3 Survey on biomass and evaluation of benefit

In early September 2017, the monitoring team conducted the third monitoring for "vegetation restoration demonstration forest in sandy areas", covering the survival rate of the plantations, situation of weeding, pest control, fire prevention, and guarding. The on-site investigation and verification shows the two sub-compartments are in good condition

Table 4-1 Monitoring results statistic on beating-up and tending of demonstration forest for vegetation restoration in sandy land   unit: mu

Compart-ment	Sub-com-partment	area	Tree species	Beating-up seedling specification	tending	Survival rate %
5	1	600	Mongolian pine, yellowhorn	I	Meet standard	93

5	2	450	Mongolian pine, Xinjiang Poplar	I	Meet standard	92

In early September 2018, the monitoring team conducted a survey on the effectiveness of "vegetation restoration demonstration forest in sandy areas", covering situation of tending, average growth, and crown width. At the same time, two afforestation plots of the same site conditions and stand factors were selected near the forest farm for the comparison of the investigation and measurement.

Figure 20 Investigation on results of demonstration forest for vegetation restoration in sandy land

By investigating, verifying and calculating to the comparison plots of the project area, the seedling growth in the project area is significantly better than that in the non-project area. And thereby the conclusion is that the project management and the technical measures implemented are appropriate and reasonable. The effect is significant. The intended purpose and requirements has been reached to the planning and design.

Table 4-2 Checklist on effect evaluation to demonstration forest for vegetation restoration in sandy land

Unit：mu

year	Compart-ment		Sub-compartment	area	tree	biomass		Comparison plot		Effect evaluation
					species	height	Canopy width	height	Canopy width	
2018	5		1	600	yellowhorn	29.1	84.2	27.2	63.9	good
					Mongolian pine	21.4	95.3	18.7	89.2	
	5		2	450	Xinjiang Poplar	38.3	77.8	19.5	62.6	good
					Mongolian pine	22.1	92	18.6	85.2	
2019	5		1	600	yellowhorn	37	98	32	85	good
					Mongolian pine	33	101	28	93	
	5		2	450	Xinjiang Poplar	43	84	34	77	good
					Mongolian pine	34	94	31	85	

4.1.3 Building of demonstration base of cash trees in sandy area

The area of wild apricots in Chifeng ranks the top of all tree species, mainly distributing on sandy land, mountains and hills. The statistics of 2014 shows that the total area is about

709,300 hm^2, of which the area of plantation is 595,300 hm^2, and the area of new establishment is 114,400 hm$^{2.}$ Among the wild apricot plantation, 371,300 hm^2 is artificially planted and 224,000 hm^2 is natural. Among the wild apricot plantation, 462,000 hm^2 can bear fruits, out of which, 320,700 hm^2 is the wild apricot plantation and 141,300 hm^2 is the natural forest. The average yield of wild apricot in Chifeng is 5.86 kg/mu. According to the study and statistics on "Selection and Research of Dominant plants of wild Apricot and the Demonstration and Promotion project" show that the yield of the dominant plant is 14.28 kg/mu in fresh.

The forest farm constructed 39 hm2 demonstration base of cash trees in sandy area in 2017, including 8 hm^2 Prunus Armenia demonstration of high-yield management, 13 hm^2 Prunus armeniaca grafting on wild apricot, and 18 hm^2 wild apricot trees demonstration of high-yield management.

4.1.3.1Demonstration of Prunus armeniaca grafting on wild apricot

Figure 21 early stage of grafting

Figure 22 effect of grafting

Since the flowering period of Prunus armeniaca is 5 days later than that of apricots, Prunus armeniaca grafting on apricot can improve the quality and the setting rate can increase by 2.41 times. wild wild fruit The selected wild apricots were planted in 2005. In May 2017, 1 to 3-year-old dominant main branches were selected as the root-stocks for grafting. The selected Prunus armeniaca variety is No. 1, taking cleft graft with the cut depth of 2 to 3 cm, tight around the interface after grafting to keep moisture and close the cut. The the graft survival rate is more than 95%. Strengthen to facilitate intensive management, including soil, fertilizer and water management, tree body management, and disaster prevention and control technologies. As for soil, fertilizer and water management, square tree trays for soil and water management, square tree-plate is made, organic fertilizer is applied, watering and weeding are done; for tree body management, open-shape pruning is done; disaster prevention and control technologies refer to white painting, pests control, fire control and guarding. The expected benefits analysis of the demonstration is as follows: the average plant yield reaches 1.3 kg, calculating at 50 plants per mu, the total is 65 kg. If at a the

market price of 14 yuan / kg, the unit benefit is 910 yuan/mu, thus the annual increase

income from the demonstration is RMB 177,000.

4.1.3.2wild apricot trees demonstration of high-yield management

Figure 23   Results of wild apricot demonstration for high-yield management

Wild apricot is a deep-rooted species with a developed root system and strong absorption with strong vitality and resistant to drought, cold, barren, salt and alkali. It plays a good role in wind break, sand fixation and soil and water conservation. It is the best choice ti build ecological forests in arid and semi-arid area or severe desertified area. The implementation plan and operation design of wild apricot demonstration for high-yield management is organized to formulate. Strengthen to facilitate intensive management, including soil, fertilizer and water management, tree body management, and disaster prevention and control technologies. As for soil, fertilizer and water management,   square tree trays for soil and water management, square tree-plate is made, organic fertilizer is applied, watering and weeding are done; for tree body management, open-shape pruning is done; disaster prevention and control technologies refer to white painting, pests control, fire control and guarding. The fruit setting rate is increased, the economic benefits are increased in the project area. The high-yield management technology is applied to fulfill an added output value is 12.02 kg/mu, and if the average price of wild apricot kernel is 6 yuan/kg, after deducting the input cost, the annual unit income increases by 22 yuan, and the income form the demonstration forest increases by about 5,940 yuan.

4.1.3.3Prunus Armenia demonstration of high-yield management

The implementation plan and operation design of Prunus Armenia demonstration for high-yield management is organized to formulate. The series technology of Prunus Armenia demonstration for high-yield management are applied, including soil, fertilizer and water management, tree body management, and disaster prevention and control technologies. As for soil, fertilizer and water management,   square tree trays for soil and water management, square tree-plate is made, organic fertilizer is applied, watering and weeding are done; for tree body management, open-shape pruning is done; disaster prevention and control technologies refer to white painting, pests control, fire control and guarding. It is of great significance to poverty alleviation in mountainous areas through   enhancing tree development to increase output through, to introduce advanced management technologies and concepts and guide farmers to strengthen the management. The fruit setting rate of Prunus Armenia and the economic benefits of the project area have been improved with the promotion and application. The expected benefits analysis of the demonstration is as

follows: the average plant yield reaches 1.3 kg, calculating at 84 plants per mu, the total is 111.6 kg. If at a the market price of 14 yuan / kg, the unit benefit is 1,562.4 yuan/mu, thus the annual increase income from the demonstration is RMB 187,000.

4.1.3.4 Investigation and evaluation on the effectiveness of demonstration base of cash trees in sandy area

1）Investigation of growth effectiveness

The height growth and crown width of wild apricot and Prunus Armenia in the sample plots are measured, and the same is done for wild apricot and Prunus Armenia in the comparison plots, and the annual average height growth and crown width are calculated. The calculation results are taken as the basis of the scientific and accurate evaluation to the management, tending and guarding of the project area.

Table 4-3　Checklist on biamassveffect evaluation of cash trees demonstration　　unit：mu, cm

year	Compart-ment	Sub-compartment	area	Prunus Armenia management		Comparison plot		Effect evaluation
				height	Canopy width	height	Canopy width	
2018	5	3	120	41.8	258.1	36.3	231.4	good
2019	5	3	120	44.3	272.9	39.2	245.8	
year	Compart-ment	Sub-compartment	area	Prunus Armenia management		Comparison plot		Effect evaluation
				height	Canopy width	height	Canopy width	
2018	5	4	195	42.7	95.5	/		good
2019	5	4	195	47.2	98.1	/		good
year	Compart-ment	Sub-compartment	area	Prunus Armenia management		Comparison plot		Effect evaluation
				height	Canopy width	height	Canopy width	
2018	5	5	270	20.8	205.3	16.2	182.7	good
2019	5	5	270	22.4	21.6	18.7	191.6	good

The calculation result in Table 4-3 shows the growth area of the Prunus Armenia and wild apricot in the project area is significantly better than that in sites with traditionally extensive management. It indicates that the project construction effect is significant.

| Figure 24 effect investigation | Figure 25 effect of grafting |

2）Investigation of yield effectiveness

Field investigation on unit kernel yield of Prunus Armenia and wild apricot in the project area is done; and field investigation on unit kernel yield of Prunus Armenia and wild apricot in the comparison plots is done, which are the basis for the evaluation of the effectiveness of the project.

Since the year 2018 is the first growing season for the grafted Prunus Armenia, the flowering is little in early spring, causing no yield.

There is no Prunus Armenia grafting project around the project area, and no way to choose a comparison plot. Therefore, an comparison investigation and evaluation can not be done.

Table 4-4 Checklist on yield effect evaluation of cash trees demonstration   unit：mu, 1/2kg

year	Compart -ment	Sub-compartment	area	Prunus Armenia management	Comparison plot	Effect evaluation
2018	5	3	120	51.2	33.7	good
2019	5	3	120	52.6	43.2	good
year	Compart -ment	Sub-compartment	area	Prunus Armenia grafting	Comparison plot	Effect evaluation
2018	5	4	195	/	/	good
2019	5	4	195	/	/	good
year	Compart -ment	Sub-compartment	area	Wild apricot management	Comparison plot	Effect evaluation
2018	5	5	270	19.6	15.1	good
2019	5	5	270	18.9	15.2	good

Figure 26 fruit setting investigation of Prunus Armenia demonstration for high-yield management

The unit kernel yield of Prunus Armenia in demonstration sites is 21.2 kg, and that in the comparison sites is 16.85 kg. The yield in the project plots is 20.5% more than that in the comparison plots. The difference is big. The unit kernel yield of wild apricot in demonstration sites is 9.65 kg, and that in the comparison sites is 7.55 kg. The yield in the project plots is 21.8% more than that in the comparison plots. The difference is big.

4.1.4 Model of under-forest economy（newly-added activity）

Due to the long cycle of chash tree demonstration, a new model of under-forest economy is taken in order to change the fact of no economic benefits in early stage of sand control. In May 2018, the forest farm carried out a trial of 40 mu under-forest planting in 2 sub-compartments of the demonstration forest for vegetation restoration in sandy area (mixed forest of *Pinus sylvestris var.mongolica* and Xinjiang poplar), growing 20mu

Figure 27 effect of under-forest growing

medical herb under the Mongolian pines in the square, including 5 mu *Rhodiola Rosea*, 5 mu *Sedum sarmenfosum Bunge*, 5 mu Red Hemerocailis, 5 mu Jinwawa Hemerocailis; and 20mu perennial flowers, the expected income can be 4,500 to 6,000 yuan per mu annually. The economic crops under the forest grows well and the project construction has achieved good results.

4.1.5 Capacity building of the forest farm

The remote and backward working environment and living conditions of the forest farm in sandy areas make it not easy for the staff to better master advanced forest ecosystem management technology. The implementation of the project gives the staff working in the basic level and the farmer opportunity to participate the project afforestation, the project management and technical training. It is of great significance to effectively improve the management level and scientific and technological capability of forester, and realize the sustainable development of forest resource utilization.

4.1.5.1Technical training

1）In early March 2017, Sanyijing Forest Farm held a technical training course on Prunus Armenia grafting on wild apricot for 50 technicians, and organized on-the-site demonstrations and technical guidance; held training on afforestation technology of Mongolian pine, Xinjiang poplar and yellowhorn for 50 technicians and manageing staff.

2）In early March to April 2018, the Forest Farm held a technical training course on tree body pruning of Prunus Armenia and wild apricot for 100 technicians and workers, and organized on-the-site demonstrations and technical guidance, which effectively secured the quality of the project.

Figure 28　technical training　　　　　**Figure 29　training course**

3）In April 2018, the Forest Farm held a technical training course on tending and managing of Mongolian pine, yellowhorn, Xinjiang poplar, Prunus Armenia and wild apricot for 50 technicians and 150 workers, and organized on-the-site demonstrations and technical guidance.

4）In July 2018, "Forest Restoration Symposium and Experience Exchange Meeting of Project area in China of Asia-Pacific Forestry Organization" was held in Chifeng. The participators visited the demonstration sites of "Demonstration of vegetation restoration and management and utilization of forest resources in Greater Asia (Chifeng site)" , the officials and experts attended the meeting give high recognition.

Figure 30　Experience exchange meeting

5）In September 2018, visited Taizhou Forest Experience Education Center in Tianshui Municipality of Gansu Province to learn their forest management experience and methods; In December 2018, visited Zhejiang Province Forest Experiencing and Nature Education Base to learn their experience and explore management methods for APFNet project. The site visits and exchange have improved the technical and managing levels.

Figure 31　visit and exchange

Figure 31 International training on comprehensive rehabilitation in Greater Central Asia

6) In March 2019, invited relevant experts to give courses for 50 the forest farm technicians and 50 workers on afforestation technology and wild apricot tree body management. A technical manual is compiled and printed for 100 copies.

7) In August 2019, attended the international training on "comprehensive rehabilitation in Greater Central Asia".

8) In July to August 2019, organized the forest farm staff and the project management office members for a domestic study tour, visited Chifeng sand control representative units, Inner Mongolian Desert Flower Ecological Industry Company, Huangyangwa Yellowhorn Industry Base, sand control demonstration base of Changsheng Sand Control Forest Farm.

9) In September 2019, attended the 14th Inner Mongolia Autonomous Region Natural Science Academic Conference Annual Branch Meeting and Joint Meeting of the Five North China Forestry Associations, and took the exchange and discussions.

4.1.5.2Summarize and compile technical and practical manual

10) The technicians summarized the production practice experience for many years, and checked a large amount of data and literature, and the "Technical Points of the Demonstration Project of Vegetation Restoration and Forest Resource Management and Utilization in Greater Central Asia" is compiled with the guidance of the senior forestry experts.
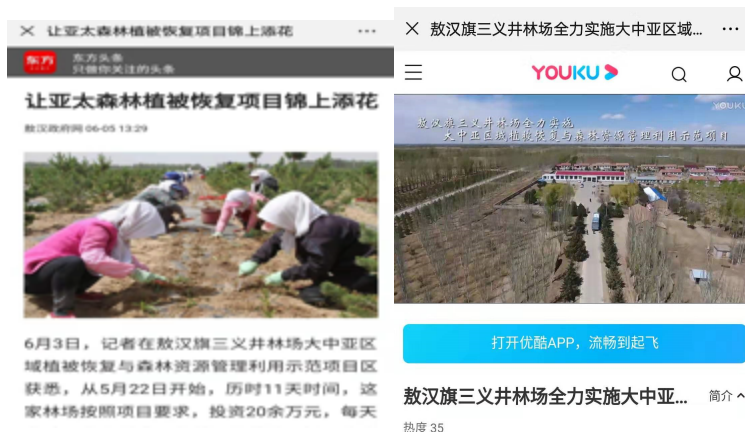

| Figure 32   technical manual | Figure 33   signboard |

4.1.5.3carry out project publicity

11) Make one set of project PPT and one publicity film video; video data are kept for

important links in the project implementation; some publicity reports on the project information, the project progress, the project achievements and the significance of the project are published in Aohan Banner Government Website, Chifeng Hongshan Evening News, Chifeng Daily, Chifeng Forestry Website, Inner Mongolia Autonomous Region Forestry Website and the magazine"Inner Mongolia Forestry", etc.

Figure 34 publicity by medias
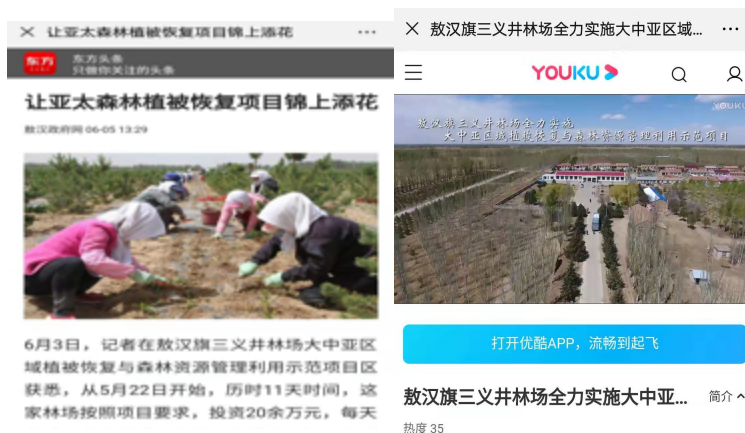
4.2 Impact of the project

4.2.1 Model Compilation and demonstration sample provision

There is a saying, "For the world to Learn desertification control from China; for China to learn it from Inner Mongolia." In 1994, Chifeng was identified as the "National experimental and Demonstration Area for sand Control". The sand control work is required to base on the whole region, serve the whole country and face to the world. Chifeng people have kept on their original mind to sand control since then. With the implementation of the project, the "typical model of sand control in Chifeng" is formulated, which is not only a review of the comprehensive sand control technology in Chifeng, but also a summary of the typical models of sand control in Chifeng. It will provide demonstration samples for sand prevention and control in the regions of the Greater Central Asia.

4.2.2 Contain land desertification and improve the ecological environment

The area of desertified land in Aohan Banner is 75,300 hm2, accounting for 9.07% of the total land area of the banner. The area with obvious desertification trend is 9,900 hm2, which accounts for 1.19% of the total land. Although the forest ecological construction of Aohan Banner has achieved great results, the ecological environment has not been fundamentally improved, and desert prevention and control are still in urgent need. The implementation of the project effectively control the disasters of wind and sand, reduce the land desertification, and improve the ecological environment.

4.2.3 Promote vegetation restoration in sandy areas and expand regional forest area

With the environment change and drought climate, the existing protection plantations in Aohan Banner appears a variety of degradation phenomena such as aging death or die-back, diseases and pests, short and old, etc. The overall forest quality appears decline, which seriously affects the multifunctional effects of the forest. The good sand fixation plant materials and the series technology of fast vegetation recovery in sandy area are summarized by the project, which can effectively improve the vegetation coverage in the project area, increase the biodiversity, ease and respond to the harms caused by the climate change, improve the quality and function of sandy land ecological system, and provide samples for vegetation restoration and construction in Greater Central Asia.

4.2.4 Take a rational and effective use of forest resources in sandy areas to develop sandy industries

Aohan Banner is a national poverty-stricken county, suffered from desertification for a long time in a severe ecological environment, backward local economy and low living standards. To reverse the situation, the banner carried out the "one reduction, three increase and two transformation" strategy during the "13rd Five-Year Plan",i.e. to reduce the degraded forests, to increase the economic forests, energy forests and special-purpose forests, to transform the low-efficiency forests and the degraded forests. The implementation of the project just fits the planning of its forestry industry. The existing low-efficiency and low-energy economic forests in the project area are transformed through series of high-yield technologies. Effective update for the economic forest in sandy area are improved. The rational utilization and the sandy industry development are promoted. The economic development in the project area and its surrounding areas is mobilized. The farmers' living condition in the project area is improved.

4.2.5 Promote the sustainable development of national energy strategy

Vigorously developing the renewable energy is an important part of China's energy development. And the development and utilization of bio-energy has become an important content for the development of renewable energy. The State Forestry Administration has included the development of forest bio-energy into the forestry development plan. As the new field of the forestry development, establishment of oil energy yellowhorn forest in sandy area just matches with the demand of the national energy strategy sustainable development. The State Forestry and Grassland Administration has approved to establish a National Yellowhorn Engineering Technology Research Center in Chifeng Scientific

Research Institute, which is also an opportunity to develop yellowhornboil energy forest by the project.

4.2.6 Improve grassroots comprehensive capability and increase ecological protection awareness

The remote and backward working environment and living conditions of the forest farm in sandy areas make it not easy for the staff to better master advanced forest ecosystem management technology, causing the forest resources in the project area hard to take a virtuous circulation and sustainable development. The implementation of the project gives the staff working in the basic level and the farmer opportunity to participate the project afforestation, the project management and technical training. Farmers' awareness of the ecological protection is increased. It is of great significance to enhance the local ecological construction and protection, and realize the sustainable development of forest resource utilization.

4.3 The sustainability

The construction content of the project is plentiful, whose activities relate to the key technologies in urgent need of sand area. The selecting plant materials are of certain economic value. It provides referable models for the development of sand industry. The outputs of the project produces good ecological, economic and social benefits. The virtuous circulation and sustainable development of forest resources are promoted.

4.3.1 The sustainability of ecological security

The project takes the strengthening of vegetation restoration, improving of forest quality, sand prevent and control , improving of ecological environment as its main purposes. It is favourable for the sustainable development of forest resources. The sustainability of ecological security in the project area and its surrounding areas is ensured.

4.3.2 The sustainability of social economy

The core content of the project is the rational utilization of forest resources and the development of the sand industry. The important targets of the project is to promote local economic development, to improve farmers' living standard in the project area and the surrounding areas, to increase employment opportunities. The implementation of the project is helpful to promote the sustainable development of local economy.

4.3.3 The sustainability of management system and policies

The project organization and management system are agreed upon common decisions by the APFNet, Chifeng government, the project implementing agency, and the technical support team, the main implementation content of which is to reach the sustainable ability and level in terms of organization composition, resource acquisition, operation management, and sustainable development. With the support of forestry policies by the government of China and the local government of Chifeng, and the cooperation commitment made by Sanyijing Forest Farm, the sustainability of management system and policies during the implementation of the project and after its completion can be ensured.

4.3.4 Follow-up activities

After the completion of the project, the project demonstration areas will maintain normal operation with the local financing and by the forest farm, especially for the various

experimental demonstration forests. To track up management technology experimental demonstration and to follow up effects of monitoring and evaluation, forestry education and training faced to Asia-Pacific regions will be organized. Further promotion and demonstration in the Asia-Pacific regions and the similar regions shall be done on basis of the summary to the advanced results and mature experience of the project.

5.Conclusions, lessons and recommendations

5.1Conclusions

The project has achieved obvious construction effects. All its activities have been completed except the times of study tour/training and the attendees not reached the requirement. Its estimated objectives are all achieved in accordance with the master plan and annual plan.

5.1.1 Aiming at the two sandy lands of Kerqin and Hunshandake in Chifeng, a overall review over the comprehensive sand control demonstration areas is made. Based on the basic factors such as sand type, sand control technology, treatment effectiveness, and treatment duration, 35 representative demonstration areas and the comparison sample plots are selected, which cover the representative sand control models in Chifeng. We compiled "Brochure for Typical Models of Sand Prevention and Control in Chifeng", relevant training courses and papers, and "Study Report on Typical Models of Sand Prevention and Control in Chifeng".

5.1.2 Build 70hm^2 demonstration forest for vegetation restoration in sandy areas; Compile operational design, normalize the specification of seedlings, the quality of planting, the ratio of mixture, the mixture method, and the planting density. The tending and the guarding are fine without animal damage; the measures of weeding, watering, and pest control done timely. The construction is good of high standard and high quality.

5.1.3 Build 39 hm^2 demonstration base of cash trees in sandy area; the measures of weeding, watering, and pest control done timely. The construction is good of high standard and high quality.

5.1.4 Make a trial of 40 mu under-forest planting, growing 20mu Licorice and 20mu perennial flowers including 5 mu *Rhodiola Rosea*, 5 mu *Sedum sarmenfosum Bunge,* 5 mu Red Hemerocailis, 5 mu Jinwawa Hemerocailis; The economic crops under the forest grow well and the project construction has achieved good results. It explores the the economic development path of sandy forests and improves the economic benefits of sandy land. It can be promoted on a large scale, and can be a typical model for the under-forest planting in desertified areas of Greater Central Asia.

5.1.5 The infrastructure construction and skill training have been carried out in order to increase the sustainable forest management capacity of the forest farm, and to broaden the perspectives of the forest farm managing staff, to reverse their management concepts for the forest farm, and to improve their managing level for the forest farm.

The self-check shows the project's expected objectives are all achieved through the implementation of the above-mentioned activities, which has been presented for APFNet evaluation.

5.2 Lessons learned and recommendations

5.2.1 Existing problems

During the implementation of the project, some extreme weathers, such as high temperature, drought, strong wind and late frost, caused some of Mongolian pines die back and the fruit-bearing of wild apricot.

5.2.2 Suggestions and countermeasures

The project is a comprehensive sand control demonstration with functions of "sand prevention and control, vegetation restoration, and resource utilization". There is no existing models for reference. It is difficult to carry out various activities and summarize the results. It still needs the working staff of the project for continuous learning and improvement in future work to meet the requirements of project management.

Vegetation restoration and forest resource management and utilization are a long-term process. The visual effects of the 3-year construction period of the project are not enough and the management results reflected by the monitoring results are relatively reluctant. It requires a long-term follow-up monitoring to examine if the models are suitable to the region.

It is recommended that the APFNet can support the construction of 2nd phase of the project, focusing on the selection of forest category and tree species suitable for the growth of the project area, and the application of the optimized configuration technology with multi-species and multi-models, to display sandy plants, to strengthen the quality and stability of forest ecosystems, and to conduct trial and demonstration of management and technology; another purpose to implement 2nd phase is to consolidate and improve the construction results for sand prevention and control, vegetation restoration and sand industry by 1st phase of the project, to continuously strengthen the capacity building of the forest farm, and to improve the sustainable forest management level and efficiency of the forest farm.

Annex A（Comparison of the estimation and the fact）

objective/output/activity	factor	Start time	Progress(complete % plus degree of output/object./achiev.）	Planned completion time	Actual completion time
Output 1 compile "study report on sand prevention and control models in Chifeng"					
Activity 1.1 survey on sand control models	Annual survey plan and annual survey report	2017.04	100%	2019.05	2019.09
Activity 1.2 compile report, promotion and application	Research report and demonstration bases of typical models	2019.06	100%	2019.11	2019.10
Output 2 Build 70hm2 demonstration forest for vegetation restoration in sandy areas					
Activity 2.1 build 30hm2 demonstration forest of mixture with Mongolian pine and Xinjiang poplar	Area, survival rate, preserving rate, growth	2017.01	100%	2019.12	2019.12
Sub-activity 2.1.1compileimplementing planning and operational design	Implementing planning and operational design	2017.01	100%	2017.02	2017.02
Sub-activity 2.1.2conduct afforestation: site preparation, wells and electricity, repair working path, planting, tending, guarding, etc.		2017.03	100%	2017.12	2017.12
Sub-activity2.1.3post management		2018-2019			
Activity 2.2 build 40hm2 demonstration forest of mixture with Mongolian pine and yellowhorn	Area, survival rate, preserving rate, growth				
Sub-activity2.2.1compileimplementing planning and operational design	Implementing planning and operational design	2017.01	100%	2017.02	2017.02
Sub-activity2.2.2conduct afforestation: site preparation, wells and electricity, repair working path, planting, tending, guarding, etc.		2017.03	100%	2017.12	2017.12
Sub-activity2.2.3post management		2018-2019			

objective/output/activity	factor	Start time	Progress(complete % plus degree of output/object./achiev.）	Planned completion time	Actual completion time
Output 3 Build 39 hm2 demonstration base of cash trees in sandy area					
Activity3.1build 13hm2 demonstration forest of prunus armeniaca grafting on wild apricot	Fruit bearing rate and yield	2017.01	100%	2019.12	2019.12
Sub-activity3.1.1compile implementing planning and operational design	Implementing planning and operational design	2017.01	100%	2017.02	2017.02
Sub-activity3.1.2conduct afforestation: site preparation, wells and electricity, repair working path, planting, tending, guarding, etc.		2017.03	100%	2017.12	2017.12
Sub-activity3.1.3post management		2018-2019			
Activity3.2 build 18hm2 wild apricot high-yield technology demonstration forest	Fruit bearing rate and yield				
Sub-activity3.2.1compile implementing planning and operational design	Implementing planning and operational design	2017.01	100%	2017.02	2017.02
Sub-activity3.2.2conduct afforestation: site preparation, wells and electricity, repair working path, planting, tending, guarding, etc.		2017.03	100%	2017.12	2017.12
Sub-activity3.2.3post management		2018-2019			
Activity3.3 build 8 hm2 prunus armeniaca high-yield technology demonstration forest	Fruit bearing rate and yield				
Sub-activity3.3.1compile implementing planning and operational design	Implementing planning and operational design	2017.01	100%	2017.02	2017.02
Sub-activity3.3.2conduct afforestation: site preparation, wells and electricity, repair working path, planting, tending, guarding, etc.		2017.03	100%	2017.12	2017.12
Sub-activity3.3.3post management		2018-2019			

objective/output/activity		factor	Start time	Progress(complete % plus degree of output/object./achiev.）	Planned completion time	Actual completion time
Output 4 capacity building of the forest farm						
Activity 4.1 Tech. training to increase quality of staff	Training on afforestation technology and wild apricot pruning for 50 technicians and 100 workers	Training report, technical manual	2017.03	100%	2017.03	2017.03
	Training on prunus armeniaca grafting technology for 50 technicians	Training report, technical manual	2017.04	100%	2017.05	2017.04
	Training on wild apricot pruning, tree body management for Mongolian pine and yellowhorn for 50 technicians and 150 other personnel	Training report, technical manual	2018.04	100%	2018.03	2018.04
	Training on technologies of tree body management for Mongolian pine, yellowhorn and prunus armeniaca for 100 personnel; compile 100 training manuals on prunus armeniaca grafting technology, high-yield management for wild apricot and prunus armeniaca, pests and diseases control technology, etc.	Training report, technical manual	2019.03	100%	2019.03	2019.03
	International Training Course on Integrated Desertification Management and Livelihood Guarantee in Greater Central Asia	Training report	2019.08		2019.08	2019.08
Activity 4.2 domestic and international study and exchange (3 times	Held "Forest Restoration Symposium and Experience Exchange Meeting of Project area in China of Asia-Pacific Forestry Organization"		2018	100%	2018.07	2018.07
	visit Taizhou Forest Experience Education Center in Tianshui Municipality of Gansu Province to learn their forest management experience and methods	Investigation summary	2018	100%	2018.09	2018.09
	visit Zhejiang Province Forest Experiencing and Nature Education Base	Investigation summary	2018	100%	2018.12	2018.12

objective/output/activity		factor	Start time	Progress(complete % plus degree of output/object./achiev. ）	Planned completion time	Actual completion time
for domestic in 3 years from 2017/08-2019/08)	visit Chifeng sand control representative units, Inner Mongolian Desert Flower Ecological Industry Company, Huangyangwa Yellowhorn Industry Base, sand control demonstration base of Changsheng Sand Control Forest Farm	Investigation summary	2019.07	100%	2019.08	2019.08
Output 5 trial of under-forest medical herbs and flowers		A set of matured under-forest growing technology on sandy land and typical models				
Activity5.1grow 20mu medical herb of Licorice			2018.05	100%	2019.12	2019.10
Activity5.2grow 20mu perennial flowers including 5 mu Rhodiola Rosea, 5 mu Sedum sarmenfosum Bunge, 5 mu Red Hemerocailis, 5 mu Jinwawa Hemerocailis		Comprehensive economic benefits 2018-2019	2018.05	100%	2019.12	2019.10
Output 6 Project monitoring and evaluation			2017.01			2019.12
Activity6.1Monitoring of project effects		Monitoring report	2017.04	100%	2019.10	2019.10
Activity6.2Monitoring of project effects		Monitoring report	2018.04	100%	2019.10	2019.10
Activity6.3Monitoring of project effects		Monitoring report	2019.04	100%	2019.10	2019.10
Activity6.4 project evaluation			2018.07	100%	2019.12	2019.12
Activity6.4.1Final acceptance report		Final acceptance report	2019.10	100%	2019.11	2019.11
Activity6.4.2Financial audit report		Financial audit report	2017.12	100%	2019.11	2019.11

objective/output/activity	factor	Start time	Progress(complete % plus degree of output/object./achiev.）	Planned completion time	Actual completion time
Output7Project publicity					
Activity7.1 In 2017, made a set of video film on project start-up and progress, made a project thematic film aided by APFNet, published one article respectively in China Green Times, China Forestry, and Inner Mongolia Forestry, released a technical Manual for 'Demonstration of Vegetation Restoration and Forest Resource Management in Greater Central Asia (Chifeng Project of China)", compiled the thematic report	Start-up meeting, medias, websites, newspapaers and magazines	2017.01	100%	2019.12	2019.12
Activity7.1.1project start-up meeting in Sanyijing Forest Farm		2017.01	100%	2017.04	2017.04
Activity7.1.2 Zhao Shucong, Board chairman of APFNet visit the project		2017.01	100%	2017.07	2017.07
Activity7.2 held the thematic workshop in 2018 and compiled the thematic report					
Activity7.2.1held the thematic workshop on vegetation restoration demonstration by Aohan Banner People's congress		2018.01	100%	2018.12	2018.06
Activity7.2.2propaganda reports China Green Times		2018.01	100%	2018.12	2018.06
Activity7.3 held the thematic workshop in 2019 and compiled the thematic report	thematic meeting, medias, websites, newspapaers and magazines	2019.01	100%	2019.12	2019.12
Activity7.3.1"Belt and Road" Asia-Pacific International Cooperation Seminar		2019.01	100%	2019.12	2019.07