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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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PREPARATORY ASSISTANCE FOR THE INDUSTRIAL EXTRACTION OF INDIGENOUS MEDICINAL PLANTS AND PRODUCTION OF PLANT-DERIVED PHARMACEUTICALS

UF/MON/91/105/11-51

MONGOLIA

Technical report: Preparatory assistance mission*

Prepared for the Government of Mongolia
by the United Nations Industrial Development Organization

Based on the work of Y. J. Chen, expert in production of plant-derived pharmaceuticals

Backstopping Officer: T. De Silva, Chemical Industries Branch

* This document has not been edited.

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Explanatory notes

The value of the Mongolian currency in US dollars during the period of the mission was 1 US dollars=355 Tughriks

Abbreviations used in this report are as follows:

BCM: Biokombinat Company of Mongolia
ITMM: Institute of Traditional Medicine of Mongolia
IFM: Institute of Folk Medicine (Former ITMM)
MMH: Mongolia Ministry of Health
MMND: Mongolian Ministry of National Development
MAS: Mongolian Academy of Sciences
RPCSE: Research and Production Company "Shine Ekhlel"
MMU: Mongolian Medical University
SPAC: State Pharmaceutical Administration of China
SCP: Shenyang College of Pharmacy.
MCMP: Mongolian Company of Medicinal Plants
MPF: Mongolian Pharmaceutical Factory
CLBPD: Central Laboratory of Biological Preparations and Drugs
SMRI: State Medicinal Research Institute
MPC: Mongolemimpex Pharmaceutical Company
TMH: Traditional Mongolian Hospitals
NDB: National Development Board under the prime Minster of Mongolia

Abstract

At the request of Ministry of National Development of Mongolia, UNIDO sent a fact-finding and preparative assitance mission to Mongolia to evaluate the present situation in Mongolia particularly the Research and Production Company "Shine Ekhlel" with respect to the possibility of producing plant-derived pharmaceuticals from indigenous plant species growing abundantly in the country; to assess available infrastructure facility for production of plant based pharmaceuticals including a laboratory for standardization and quality control; to assess the market potential for the plant-derived pharmaceuticals both internal and external.

The mission visited the following institutions: UNDP office in Ulaanbaabar, Research and Production Company "Shine Ekhlel", Biokombinant Company of Mongolia, Institute of Traditional Medicine of Mongolia, Mongolian Academy of Sciences. Mongolian Medical University. Mongolian Company of Medicinal Plants, Mongolian Pharmaceutical Factory, Central Laboratory of Biological Preparations and Drugs, State Medicinal Research Institute, Mongolemimpex Pharmaceutical Company, Traditional Mongolian Hospital, Export Company and Ministry of National Development. Having visited these institutions, the mission came to the following conclusions:

(1) Mongolia is rich in natural resources of medicinal and aromatic plants. Some of medicinal plants are cultivated in several cultivation Stations.

(2) Many companies, particularly the Research and Production Company "Shine Ekhlel" can produce some plant-derived pharmaceuticals. These preparations should be improved in terms of both quality and standardization.

(3) They have some basic facilities for production and quality control. But most of the equipments are too simple, too primitive. They need a pilot plant.

(4) Plant-based medicines are much used in the health care delivery system of Mongolia. The internal market for plant-derived pharmaceuticals is good. Some of products could be exported abroad.

The mission identified RPCSE as the institution with a clear mandate to carry out phytopharmaceutical production and research works. The company has integrated industrial facilities and a laboratory, qualified manpower and a large land for expansion and cultivation of medicinal and aromatic plants. It can produce some plant derived pharmaceuticals. The mission drew up a project proposal for UNDP/UNIDO technical assistance to strengthen the facilities and capabilities of RPCSE.

I. INTRODUCTION

A. Objectives of the mission

The project in Mongolia UF/MON/91/105/11-5/ was started on the first of August and ended on the third of September, 1993. The technical report and the draft project document were written by the UNIDO consultant, Prof. Chen Ying-Jie, Expert in the production of plant-derived pharmaceuticals.

The objective of the mission was assessment of the feasibility of industrial extraction of indigenous medicinal plant and production of plant-derived pharmaceuticals in Mongolia as the basis of a technical assistance or/and technical co-operation programme for the development of plant-based pharmaceuticals. The job description of the UNIDO consultant is given in Annex 1.

Thanks to the valuable assistance offered by UNIDO and UNDP officers and the cooperation of the Mongolian people, The objectives were successfully attained.

B. Brief information on Mongolia

Mongolia is one of the biggest countries in Asia. It covers an area of 1,566,500 square kilometers. Mongolia stretches about 2,400 kilometers from the west to the east and about 1,260 kilometers from north to south and is bounded on the north by the Russian Republic and on the south by the People's Republic of China.

Mongolia is a mountainous country with an average altitude of 1,580 meters above the sea level. The geography of the country is characterized by great diversity. In the northwest the mountain ranges are overgrown with wild forests, including some medicinal trees. The Gobi desert lies in the southern parts where many important medicinal plants, such as Glycyrrhiza uralensis, Ephedra equisetina etc. grow. The part of the country is semi-desert and grassland providing fine pastures and hundreds of medicinal and aromatic plants.

The population of Mongolia is 2,141,000 out of which 45% is regarded as nomadic herdsman. Ulaanbaatar, the capital, has a population of about 528,400, accounting for one fourth of the total population. It is also the political, economic and cultural center of Mongolia.

C. Medicinal and aromatic plants in Mongolia

Due to the large area of the country and its great diversity of geography, Mongolia has 650 varieties of herbs grown in Alpine steppes, mountain regions and deserts. Many wild indigenous plants are very rich in resources. Natural thickets of Glycyrrhiza uralensis Fisch, Ephedra equisetina Bge. Piptanthus mongolicus M., Artemisia annua L. and others here and there seem like artificial plantations. Some of medicinal plants are exported abroad, for example herbs of Ephedra equisetina Bge are exported to China for producing l-ephedrine and d-pseudoephedrine. Roots of Astragalus mongolicus and licorice (roots and rhizomes of Glycyrrhiza uralensis Fisch) are exported to Korea and Bulgaria. In addition to the rich natural resources of wild medicinal and aromatic plants, some raw materials of plant-origin can also be supplied by the cultivation stations. As far as the consultant know, there are at least six big cultivation stations for growing medicinal and aromatic plants in Mongolia. Over ten species of plants are cultivated in these stations on large scale. The cultivation-station of Research and Production Company "Shine Ekhlel" can supply 300 tonnes of licorice per annum. Industrial extraction of these medicinal plants will create big property.

Plant-based medicines are much used in the health care delivery system of this country. Some plant medicines come from China through boundary trade. Some plant based pharmaceuticals are produced by Mongolian companies or institutions. The Institute of Traditional Medicine of Mongolia can produce about 50 kinds of preparations in small scale. All of these products are only used in the clinic department of this institute. Mongolian pharmaceutical factory produces mainly western preparations. There is a workshop in this factory, where a few plant-medicines are produced. The Research and Production Company "Shine Ekhlel" is the unique company which undertakes the tasks of both research and production of plant-based pharmaceuticals. Now RPCSE produces 20 kinds of plant-derived pharmaceuticals in large scale along with 32 kinds of plant products produced in small scale. So it can be considered that phytopharmaceutical industry has already existed in Mongolia but, equipments and facilities used are too simple and far from enough. There is still no good laboratory for quality control and standardization. Some technology transfer and manpower training are required.

The mission identified RPCSE as the only company in this country with a clear mandate to research and production of plant-derived pharmaceuticals. This company has integrated some industrial facilities, a laboratory for research and quality control, qualified manpower and large land for cultivation of medicinal and aromatic plants. This company is situated in the industrial zone in suburb of Ulaanbaatar. Electricity and water supply can be assured in this region. This mission drew up a draft project document for UNDP/UNIDO technical assistance to improve the facilities and capabilities of RPCSE.

II. INSTITUTIONS VISITED

A. UNDP-Ulaanbaatar

As soon as the mission arrived in Ulaanbaatar, the consultant visited the UNDP office in Ulaanbaatar. Mr. G. Gankhuyag welcomed the mission and discussed the jobs and schedule arrangements for the mission's work in Mongolia.

At the end of the mission's work in Mongolia, Mr Shun-Ichi Murata, the Deputy Resident Representative of UNDP met the mission with Mr. Miagmar, the general director of RPCSE. The mission reported his findings in Mongolia. The key points written in the technical report and draft project document were understood and appreciated by Mr. Shun-Chi Murata and Mr. G. Gankhuyag.

B. Research and production company "Shine Ekhlel" (RPCSE)

Research and Production Company "Shine Ekhlel" (RPCSE) is also called Mongolia Scientific Production Company "Shine Ekhlel" which is situated at the foot of peace mountain in the southern suburb of Ulaanbaatar city. It was established in 1978 as a plant-derived pharmaceutical experimental station within the Veterinary Research Institute (VRI) in Uaanbaatar. Then in 1988, it was reorganized as this Scientific Production Company "Shine Ehlel", the unique natural pharmaceutical company in Mongolia.

There are 105 staff members now in this company, including 44 researchers, engineers, technicians and 61 workers. Most of these researchers, engineers and technicians have graduated from universities. Some of them had studied in Soviet Union and east-European countries. The general director of RPCSE, Dr. J. Miagmar, is an intelligent and energetic leader. He wrote several books on Mongolian medicinal plants in collaboration with other authors. He is full of ideas and he is soliciting some cooperation with other countries as well as international organizations such as UNIDO and UNDP to improve the industrial extraction of medicinal plants and production of plant-derived pharmaceuticals. The two deputy directors, O. Bat-Erdene and J. Baatar, are also full of abilities and hard-working persons. In addition, this company has invited scientific advisors, such as O. Purev, to strengthen the R & D ability. This company has stronger manpower. But they are short of experience for management of modern phytopharmaceutical company. So they would better to be retrained abroad.

RPCSE has a company building of about 2000m² construction area. There are five departments in this building as follows:

1. Management department.
2. Technical department.
3. Plant-derived pharmaceutical department.
4. Animal-derived pharmaceutical department.
5. Cosmetic department.

The tasks of the technical department are research and development of plant-derived pharmaceuticals and quality control. In fact, the equipments of this laboratory are too simple and too short to do R & D and quality control. Some of these works are carried out in the Institute of Chemistry of Mongolian Academy of Sciences. A few scientists are invited from MAS to this company to give technical assistance. The consultant only saw a few old equipments in this laboratory. They are a balance, a UV/Vis spectrophotometer, a refrigerator, a vacuum dryer and some glassware. There are no HPLC, TLC and GLC equipments.

In the pharmaceutical and cosmetic departments, the mission saw some simple and very crude equipments. There are an old grinder, a ball-mill-pulverizer, a simple extractor, water-distillator, a percolator, an old tablet-machine, liquid-packing equipment and so on.

In order to meet the need of Mongolian people for natural pharmaceuticals, twenty kinds of plant-based pharmaceuticals are produced now in this company (Table 1). The dosage forms of these preparations include powders, tablets, oral liquid and injection (for animal use). Most of these products are appreciated by Mongolian Government and people. But the consultant considers that it is very necessary for this company to improve its facilities equipments, including a laboratory for standardization and quality control by using UNIDO and UNDP's technical assistance.

Table 1. List of Products Produced by RPCSE

Name of products	Name of plants	Dosage forms	Usages
Chigatussin	Acassia tora	liquid	stomach ache
Altangagnur	Rhodiola rosea	liquid	tonic
Sod	Sanquisorba officinale	liquid	stop bleeding
Fantecrin	Rhodiola rosea	liquid	tonic
Tarbagan Shir	Thermopsis lanceolata	tablet	anti cough
Gensichol	Gentiana barbata	tablet	gall inflammation
Horom chon		oil	ulcer,wound
Pontalt	Rhodiola rosea	wine	tonic
Gumsintopeg		oil	ulcer
Barag shun		liquid	anti cancer

Bergaplol	Bergenia crassifolia	tablet	intestinal disease
Plantago	Plantago major	liquid	rectum and stomach diseases
Cielot		tablet	
Badglumiccin	Bergenia crassifolia leavomycetin	tablet	rectum disease
Bergena crassifolia	Bergenia crassifolia	powder	digestive disease
Artemisia santalinifolia	Artemisia santalinifolia	powder	digestive disease of animal
Rhodiola rosea	Rhodilla rosea	powder	tonic
Sophora alliapicreides	Sophora alliapicreides	powder	asthma
Targa	Piptanthus mongoticus	Inject ion	metabolism stimulating agent for promoting growth of animals
Maral		liquid	tonic

In addition, there are three plant-cultivating stations and a animal-raising station in this company. The plant-cultivating stations now cultivate Glycyrriza uralensis Fisch and Thermopsis lanceolata R. Br. in large scales. Estimated yield of Licorice (roots and rhizomes of G. uralensis) is 300 tonnes a year. This company hopes that the industrial extraction of glycyrrhizic acid could be realized by international cooperation. This company has some good collaboration with Mongolian Academy of Sciences, Institute of Traditional Medicine of Mongolia and some institutions in Russia and other countries.

C. Mongolian Academy of Sciences (MAS)

Mongolian Academy of Sciences (MAS) is the top level scientific organization consisting of Institutes of Chemistry, Biochemistry, Biology, Mathematics, Physics, etc. The mission visited only the Institute of Chemistry where a group of scientists carries out research into phytochemistry of Mongolian medicinal plants. This has most advanced equipment in Mongolia, such as UV, IR, MS, NMR apparatus for elucidation of structures and HPLC. GC equipment for analysis as well as

preparation. In recent years, about thousand natural compounds were isolated from Mongolian medicinal and aromatic plants. Among them, fifty were new compounds. In addition to basic research, some applied research on plant-derived pharmaceuticals is also conducted in collaboration with RPCSE and other companies. And some of the research results has already been applied in production of plant derived medicines. For example, "Targa", a cell- stimulating agent for promoting animal growth, was one of applied research results of this institute in collaboration with RPCSE. This product has been produced by RPCSE for many years and it is highly appreciated by Mongolian government and animal husbandry institutes.

There are seven scientists of the institute working in the RPCSE for two days a week to combine the basic research with applied research work.

The other research fields of this institute are inorganic chemistry, organic chemistry, energy chemistry, food chemistry and mineral technology etc.

D. Institute of traditional medicine of Mongolia (ITMM)

The institute of traditional medicine of Mongolia is under the leadership of both Mongolian academy of sciences and Mongolian ministry of health. It was established in 1973 named as Institute of Folk Medicine (IFM) which was enlarged and changed by name into ITMM in 1990.

ITMM occupies a building about 3000m² construction area with 150 staff members, including 50% scientists, most of them have been to Soviet Union and other east european countries to study for 1-5 years. Among them, four persons are senior scientists with C. Sci degree.

Under ITMM, there are 8 departments as follows:

1. Department for natural resources of medicinal plants
2. Department for cultivation of medicinal plants
3. Department of pharmacognosy
4. Department of phytochemistry
5. Department of pharmacology
6. Department of pharmaceutical formulation
7. Department of manufacturing preparations
8. Clinical department

The main tasks of ITMM are investigation of medicinal plants and clinical treatment of diseases with Mongolian plant-based or animal-derived pharmaceuticals.

In the department for cultivation of medicinal plants, there is a cultivation station where 10 species of medicinal plants are cultivated, including Aconitum barbatum, Cistanche salsa. etc.

They are also planning to cultivate Panax ginseng C.A. Meyer in collaboration with Chinese scientists.

Now, ITMM is studying five main projects:(1) Study on the tonic effect of Cistanche salsa; (2) Study on anti-hepatitis principles of Gentiana spp.; (3) Taxonomic study on Mongolian medicinal plants; (4) Study on Ancient Tibetan and Mongolian medical books; (5) Study on traditional Mongolian medicines which are used for treatment of cardiovascular diseases.

In the clinical department, there are ten Mongolian traditional doctors working for treatment of common diseases by using Mongolian traditional medicines, mainly plant-derived pharmaceutical preparations and some animal-based pharmaceuticals. Most of the preparations used in this clinical department are produced in ITMM's department for manufacturing preparations which can produce 50 kinds preparations with only three types of dosage forms: powders, tablets and oral liquids. The equipments and facilities for producing preparations are very simple and backward. The mission saw in person that workers were pressing the extracted plant-residues by hands instead of machines.

ITMM is active in international exchange. A famous Japanese scientist, Professor Namba of Toyama Medical and Pharmaceutical University was invited to this institute to give a lecture. ITMM has a good relationship with China Huhehot Institute of Traditional Medicines and China Tungliao Mongolian Medical College. Some equipments, for example, powder-packing machine was also imported from China. Some Chinese Mongolian doctors were invited to ITMM to treat mongolian patients. They were greatly welcome by Mongolian patients.

E. Biokombinat company of Mongolia (BCM)

Biokombinat Company of Mongolia (BCM) is situated in songino district of Ulaanbaatar. BCM is a large biological company producing veterinary biologicals. It was established in 1923 on the basis of an antiplague station furnished by Soviet technicnology and equipments. Then in 1973, BCM was rebuilt with the technical and economic assistance of Hungary and now it become the largest biological company in Mongolia.

BCM has departments for biological preparations, diagnostics, serum, vaccine, chemistry, microbiological etc. BCM has 350 staff members, including 370 workers, 35 engineers 15 senior engineers and 30 veterinary doctors.

The facilities and equipments in BCM are comparatively advanced. For example, Seitz apparatus for sterile filtration of hyperimmune serum, different types of fermentors, glass fermentors for multiplication of microorganisms, fermentors of 100 and 200L of capacity for propagation of salmonella bacteria, fermentors of 600 L capacity for mass production of vaccines,

spectrophotometers, spray-drier, freeze-drying apparatus, high speed centrifuger etc. Progressive methods are used in BCM, such as cultivation of cells, freeze-drying of live microorganisms, testing of diagnostics (antigen, sera, etc) by means of serological and bacteriological methods titration of virus strain on embryonated eggs.

Now BCM turns about 70 biologicals for diagnostic, prophylactic curative agents, culture media and antibiotics etc. 5 kinds of products are exported to abroad.

Quality control is well performed in BCM. Every batch of biological products are tested for potency, safety and sterility.

F. Mongolian company of medicinal plants (MCMP)

Mongolian Company of Medicinal Plants (MCMP) has three departments:

1. Cultivation department is responsible for cultivating medicinal and aromatic plants. There are four cultivation stations under this department. More than 10 Species of medicinal plants are cultivated in these four stations.

2. Collection department is responsible for collecting wild indigenous medicinal and aromatic plants. Every year, over hundred species of medicinal plants are collected from different parts of this country.

3. Department for post-harvest treatment. There are one cutting machine imported from Germany, cleaning machines, pulverizers and drying rooms.

It has a total staff of 70 persons, including 10 senior agronomists and engineer, rest of them are technicians and labourers.

The crude drugs after post-harvest treatment will be supplied to pharmaceutical companies and hospitals. Some crude drugs are exported abroad.

G. Mongolian pharmaceutical factory (MPF)

Mongolian Phamaceutical Factory (MPF), belonging to the Ministry of Health, is situated within the Uaanbaatar city. There are over 300 staff members, including 20 engineers and senior engineers. Some of them had been to Poland to be trained.

The main task of MPF is producing western-style medicines, which occupies about 20% of the medicines required by this country. MPF produces also plant-based pharmaceuticals. The output ratio of western-style medicines to plant-based medicines

is about 5:1.

There are five departments in this factory as follows:

1. Tablet Department: 29 kinds of tablet pharmaceuticals are produced in this department, including levomycetin, glutaminic acid, analgin, vitamin C, luminal (phenobarbital), ephedrol and so on. It is notable that production of ephedrol needs ephedrine which is imported from China, while large amount of herbs of Ephedra equisetina are exported to China frou this country. So The mission strongly recommend to establish a joint venture company with China for producing ephedrines so that the import saving and export earning could be achieved in this field.

2. Injection Department: 10 kinds of injections are produced in this department, including novacain, analgin, dibazol etc.

3. Department for Blood Products and Substitutes: the main products manufactured in this department are 0.9% sodium chloride, 5% glucose and 5% aminocaproic acid.

4. Department for Dressing Bandage: Cotton wool, gauze and women bandages are produced here.

5. Department for Plant-based Pharmaceutical: Two main products, tincture of valeriana and arch along with some products manufactured in small scale are produced in this department.

H. Central laboratory of biological preparations and drugs (CLBPD)

The Central Laboratory of Biological Preparations and Drugs (CLBPD) is under the Ministry of Health of Mongolia. CLBPD is the highest institution in this country for standardization and quality control of biological preparations and drugs. There is no HPLC and GC equipments here. CLBPD can carry out simple qualitative and quantitative analyses of western medicines by using common chemical means. No standardization and quality control of plant derived pharmaceuticals can be done in this laboratory.

I. State medicinal research institute (SMRI)

The State Medicinal Research Institute (SMRI) is a very small institution under the Ministry of Health of Mongolia. There are eight staff members here, including three researchers, two technologists and three pharmacists. The equipment found here are very simple. What the mission could see was only glassware and some tanks, plates for TLC experimental use. There is no HPLC, no GC, even no fraction collector for column chromatograph, no rotatory evaporator. They are now performing an anti-hepatitis study on Bupleurum scorzonerifolium Willd. It was said that this

medicinal plant could be expected to be used for treatment of hepatitis. Complicated research problems are usually solved in collaboration with the Institute of Chemistry, Mongolian Academy of Sciences.

J. Mongolemimpex pharmaceutical company (MPC)

Mogolemimpex Pharmaceutical Company (MPC) is a big company under the General Department on Manufacture and Supply of Drugs and Medical Equipment, Ministry of Health. MPC has its headquarters in Ulaanbaatar and it has 542 medicine stores located in cities and provinces of this country. There are total 3000 staff members working in the headquarters (70 persons) and all medicine stores.

The main tasks of MPC are as follows:

1. Medicine import: Each year, about thousand kinds of medicines and chemicals are imported from Germany, Soviet Union (Russia) Japan, England, Hungary, Holland, Austria and China. The bill for importing medicines reached 10 millions each year. Eighty percent of western medicines needed in this country is imported.

2. Medicine purchase: MPC purchases medicines produced by Mongolian pharmaceutical factory and many pharmaceutical companies.

3. Medicine supply: all of these medicines, including imported medicines from abroad, medicines produced in Mongolia, are supplied through the 542 medicine stores distributed all over the country to hospitals and clinical units.

K. Traditional Mongolian hospitals (TMH)

There are about 100 Traditional Mongolian Hospitals (TMH) in Mongolia. The biggest TMH of Mongolia is the Balneology Center (BC) in Ulaanbaatar. BC has 140 staffs, including 10 Senior Doctors and 30 Doctors. About 300 patients are treated in this BC each day. In additions, there are wards with 300 beds in this BC. A few Japanese people are also treated here.

The main traditional therapeutic methods in this BC are treatment by using plant derived pharmaceuticals, massage, acupuncture etc.

According to the statistics made by the Ministry of Health, 70 percent of Mongolian people believes in traditional Mongolian medicine and likes to be treated by traditional Mongolian medical methods.

L. Ministry of national development

Ministry of National Development (MND) is also called as National Development Board (NDB) under the Prime Minister of Mongolia.

The mission reported his works in Mongolia, especially explained the technical report and draft project document to Mr. J. Khurelsukh, the director of Department of Technology and Investment Policy of NDB.

On behalf of NDB, Mr. J. Khurelsukh agreed with the conclusions and recommendations of the technical report as well as the draft project document. He expressed great thanks to UNIDO for its help to Mongolia with development of phytopharmaceutical industry. He said that NDB will do its best to support this project if this project document (draft) is approved by UNDP and UNIDO. NDB will organize a National Project Committee (NPC) to coordinate the implementation of the project.

NDB also agreed with the mission's qualification of RPCSE for UNDP/UNIDO support to set up pilot plant and a laboratory for standardization and quality control. Mr. J. Khurelsuku said that RPCSE has made great progress in research and production of plant-derived pharmaceuticals. RPCSE is in a good condition to make the project successful. This project will be great meaningful for Mongolia to improve and develop its phytopharmaceutical industry.

M. Mongolian national medical university

The Mongolian National Medical University (MNMU) was organized in 1942. Now MNMU has 12 fundamental departments and 11 clinical departments: The main departments concerning the mission's works are the Department of pharmacy, Department of pharmacology and the Department of Mongolian traditional medicine. In addition to education of students, the teachers in Dept. of pharmacy and Dept. of pharmacology do some research and development of new drugs from medicinal plants growing wild in Mongolia. In recent years 10 kinds of new plant-derived pharmaceuticals were developed in these two departments in collaboration with Mongolian Academy of Sciences. The equipments used for research are very short and simple. The mission only saw an old tablet machine and a photometer along with some glassware.

The Department of Mongolian traditional medicine is responsible for education of future doctors of Mongolian traditional medicine. After graduation, most of the students will go and work at Mongolian traditional hospitals.

MNMU is the top level medical university in Mongolia. Up to now, 5387 medical doctors. 1344 pediatricians, 616 public health workers, 498 dentists and 447 pharmacists and pharmaceutists graduated from this university. 180 persons defended scientific

degree and made contributions to the medical and pharmaceutical development in Mongolia.

III. INVESTIGATION INTO NATURAL RESOURCES OF MEDICINAL PLANTS

The mission had been to Mandsheer and Schar-Cholou regions to investigate into natural resources of medicinal and aromatic plants in this country personally, in addition to discussion with taxonomists, pharmacognogists and reading some reference books.

The mission enjoyed Mongolian beautiful landscape, a nature-lover's paradise. The mountains are overgrown wild forests, including some medicinal trees. The grasslands provide not only fine pasture, flowers, but also many medicinal and aromatic plants. Some of them are very rich in natural resources. The natural thickets of Papaver nudicaule, Rosa davurica, Vicia amoena, Campanula punetata, and Scabliola comosa seem like artificial gardens.

In these two regions, the mission saw over hundred species of medicinal and aromatic plants. Among these species, three plants, Scabiola comosa, Berberis amurensis and Artemisia annua are abundant.

Becuase of limited time and inconvenient transportation, the mission could not to go to Gobi area which is far away from Ulaanbaatar as it would take four days to go and return.

IV. CONCLUSIONS AND RECOMMENDATIONS

On the basis of the mission's observations and visitations to pharmaceutical companies, research institutes, university, hospitals, government departments and organizations, and investigation into natural resources of medicinal and aromatic plants, the mission has reached the following conclusions and recommendations

A. Assessment of the potential of medicinal and aromatic plants for industrial utilization

Mongolia is one of the largest countries in Asia with a total area of 1,556,500 square kilometers. The geography of the country is characterized by great diversity. In the northwest, the mountain ranges are overgrown with wild forests. The Gobi desert lies in the southern part which is rich in Ephedra equesetina and Glycyrrhiza uralensis Fisch. The rest part is grassland providing fine pastures and many medicinal and aromatic plants.

A book titled" The Key for Identification of Mongolian Medicinal Plants" written by B.U. Grubov contains 650 Mongolian

medicinal plants. H. Tumbaa, and J. Miagmar et al. compiled 280 species of Mongolian medicinal plants containing alkaloid compounds in their book titled " Mongolian medicinal plants containing alkaloid compounds" (in Monglian, Ulaanbaabar, 1988). Another book named " The Bioactive Compounds in Mongolian Medicinal Plants" (in Mongolian, Ulaanbaatar, 1988) written by H. Tumbaa and J. Miagmar contains 64 families, 430 species of medicinal plants along with 250 kinds of bioactive compounds contained in these plants.

Mongolian people use medicinal plants not only for treatment of human diseases, but also for treatment of animal's diseases because animal husbandry is a very important part of the economic structure of this country. H. Tumbaa, S. Choi and J. Miagmar compiled 56 plant-derived medicines, including prescriptions, preparations, administrations and dosages, in their book " Recommendation for Using Medicinal Plants in Treatment of Veterinary Diseases (in Mongolian, Ulaanbaatar 1984). Another book "Plant-Medicines Used for Treatment of Veterinary Diseases" (in Mongolian, Ulaanbaatar, 1990) was also written by H. Tumbaa, J. Miagmar. The latter person is the general director of RPCSE, the main counterpart of this mission. In his company plant-derived pharmaceuticals are manufactured for both human and veterinary use. For example, TARGA is one of the leading products of this company, which is well known as a cell-stimulating injection used for promoting animal growth.

In order to investigate into the natural resoures of medicinal and aromatic plants, the mission had been to Mandzsheer mountain region 50 km away from Ulaanbaatar and to Schar-Cholou region. In the two small regions alone where the mission had been to, the consultant found in person over 100 species of medicinal plants. Among them, there are three indigenous plant species growing abundantly in these regions. All of the three plants could be considered for industrial utilization.

Some of these wild growing herbs can be cultivated on large area in various parts of this country. The cultivation of medicinal and aromatic plants will ensure a steady supply of raw materials for industrial utilization. This will also result in creating employment opportunities in rural area. Now more than 10 species of medicinal and aromatic plants are cultivated in differen. scales. The main cultivated plants include Glycyrrhiza uralensis Fisch, Thermopsis lanceolata R. Br. Ephedra equisetina Bge, Adonis mongolicus, Cistanche salsa (C.A. Mey) G. Beck, Hippophoe rhamnoides L. and so on.

Generally, the natural resource of some wild indigenous plants are very rich, such as Glycyrrhiza uralensis, Ephedra equisetina, Artemisia annua, Rhodiola rosea, Piptanthus mongolicus. Some of medicinal plants are cultivated as mentioned above. The mission recommends that the following plants (Table 2) could be used for industrial extraction or production of plant-derived pharmaceuticals.

Table 2. List of Potential Plants for Industrial Utilization

Names	Notes
Glycyrrhiza uralensis Fisch.	wild and cultivated. yield: about 300 tons/year
Thermopsis lanceolata R.Br.	wild and cultivated. yield: about 50 tons/year
Ephedra equisetina Bge.	wild, cultivated. yield: 1000 tons/year
Piptanthus mongolicus Maxim.	wild, plan to cultivate. yield: 500 tons/year
Rhodiola rosea L.	wild, plan to cultivate. yield: 60 tons/yesr
Cistandhe salsa (C.A.Mey.)G.Beck	wild and cultivated
Hippophoe rhamnoides L.	wild and cultivated
Artemisia annua L.	wild and plan to cultivate. yield: 500 tons/year
Adonis sibiricus Pall.	wild and cultivated
Chelidonium majus L.	wild
Sambucus sibirica Nagai.	wild
Gentiana barbata Froel.	wild
Acorus calamus L.	wild
Berberis sibirica Pall.	wild
Stellaria dichotoma L.	wild

The resources for selecting these medicinal and aromatic plants are as follows:

1. Natural resources of these plants are rich in Mongolia and they can be or have already be cultivated in large scale.

2. The pharmaceuticals derived from these plants can be used for treatment of common diseases in Mongolia or for exporting abroad to earn more hard currency.

Among the plants listed in Table 2, the mission strongly recommends the industrial utilization of Glyryrrhiza uralensis, Ephedra equisetina, Piptanthus mongolicus, Artemisia annua and Rhodiola rosea.

The roots and rhizomes of glycyrrhiza uralensis can be used for industrial extraction of glycyrrhizic acid which are used for treatment of stomach ulcer, hepatitis and Aids diseases. In addition, it is also one of the important food addictives. So the

international market is very big, although China is exporting licorice and glycyrrhizic acid in large amounts, it still can not meet the needs of the strong international market. Mongolia is rich in wild Glycyrrliza uralensis. And what is more, large area of cultivation of this plant is already carried out in the cultivation station of RPCSE, with yield of 300 tonnes per annum. If this raw material was converted into glycyrrhizic acid and exported abroad, RPCSE could earn about 150,000 US dollars a year. So the consultant suggests that with the assistance of UNIDO and UNDP, RPCSE should establish a special facility for industrial extraction of glycyrrhizic acid. In this field, Shenyang College of Pharmacy and its pharmaceutical factory could be expected as a potential copartner which has enough experts, engineers, managers and the technologies.

The herbs of Ephedra equestina are used for industrial extraction of l-ephedrine, d-pseudoephedrine, l-methglephedrine, d-methyl ephedrine, l-norephedrine and d-norephedrine. The first two alkaloids are very rich in the herbs with total yield from 0.5% to 1.2% calculated on the air-dried herbs. In the international markets, USA and Japan need large amount of l-ephedrine and d-pseudoephedrine. But in Mongolia, there is no ephedrine industry at all. Mongolia exports herbs of Ephedra to China. In China, there are six pharmaceutical factories producing l-ephedrine and d-pseudoephedrine on a large scale. China is the biggest exportor of natural l-and d-pseudo ephedrine. The natural ephedrines with trade mark "Red Horse", which are manufactured in China, are very famous and these products can not meet the demand of international markets. The mission recommends that Mongolian Ministry of National Development and Mongolian Ministry of Health would pay more attention to ephedrine industry. The consultant considers that the best way for development of Mongolian ephedrine industry is to establish a joint-venture company with China. Mongolian side should better contact the State Pharmaceutical Administration of China (SPAC) which is the leading organization of all pharmaceutical industry in China through the help of UNIDO and UNDP. In this field, China has experienced experts, engineers and advanced technologies. SPAC could be expected to arrange a copartner for Mongolian side.

Piptanthus mongolicus is very rich in Mongolia. In addition, RPCSE will cultivate it in the cultivation station of the company so that a steady supply of this raw material is ensured. Especially RPCSE has been producing an injection named "TARGA" by using Piptanthus mongolicus. TARGA is cell-stimulating agent used for promoting animal's growth. Experimental results showed that sheep which was injected with 4 ml of TARGA increased 4 Kg more meat than control group in 45 days.

In the case of pigs, 50 percent more meat was increased than the control group. This product is meaningful for Mongolian husbandry. If the quality of the product was well controlled, TARGA could be exported to Australia, USA etc. the consultant payed attention to modernization of equipments for producing this product using a pilot plant provided by UNIDO and UNDP.

Artemisia annua L. is very rich in Mongolia. This plant contains essential oil which can be used for cosmetics and soap. Now Mongolia is importing large amount of cosmetics from abroad. Hence using essential oil of Artemisia annua for producing Mongolian cosmetics is hopeful. RPCSE is manufacturing some soap and cosmetics using this essential oil. But the equipments are backward and quality control should be carried out.

B.Evaluation of the present situation in Mongolia particularly the Research and Production Company "Shine Ekhlel" with respect to the possibility of producing plant-derived pharmaceutical from indigenous plant species growing abundantly in the country

1. Present situation of possibility of producing plant-derived pharmaceuticals in Mongolia

Phytopharmaceutical industry in Mongolia has already existed although it is still in childhood state. There are several units producing plant-derived pharmaceuticals. In ITMM, there is a department for manufacturing plant-derived and animal-based preparations. About 50 kinds of preparations (powders, tablets and oral liquids) are produced in small scale in this unit. All of these products is only used in their own clinic department for treatment of clinic patients.

Mongolian pharmaceutical factory is mainly producing western medicines. But there is a workshop in it for producing plant-derived pharmaceuticals. Here a few plant-derived drugs are manufactured for commercial purpose. For examples, drug "Arch" is a powder preparation made of Juniperus sabina. It is used for treatment of heart disease. Another product is " Tincture of Valleriana" made of Valleriana officinalis for treatment of insomnia.

The unique phytopharmaceutical company in Mongolia is RPCSE which conducted both research and production of plant-derived pharmaceuticals. Now twenty kinds of plant-derived pharmaceuticals are manufactured in this company (See table 1). All of these products are produced for commercial purpose and available in Mongolian internal markets. The dosage forms of the pharmaceuticals include powders, tablets, oral liquids, medical wines and injection (for animal use). Most of these products are well estimated by Mongolian Government and people.

General speaking some companies, particularly the Research and Production Company "Shine Ekhlel", can produce plant-pharmaceuticals. But, the phytopharmaceutical industry in Mongolia is still in his childhood state, because facilities are simple and backward. The quantity and quality are far from the requirements of health care in Mongolia.

2. Prospects for improving production of plant-based pharmaceuticals

Very bright prospects for improving production of plant-based pharmaceuticals are in Mongolia. There are 650 varieties of herbs grown in this country. Many of them are indigenous and the resources of wild plants are rich. Natural thickets of glycyrrhiza uralensis Fisch. Ephedra equisetina Bge, Piptanthus mongolicus M., Artemisia annua L. and others found look like artificial plantations. Some of these wild growing herbs can be and have already been cultivated on large scale in various parts of the country. So steady supply of some important raw materials for industrial extraction of plant's active substances and production of plant-based medicines is no problem in this country. The phytopharmaceutical industry established, even in its childhood stage, can serve as a basis and starting point to improve and develop plant-based pharmaceuticals.

With the improvement of production of plant-based pharmaceuticals, the following results could be obviously obtained:

1) Needs of Mongolian people for plant-based pharmaceuticals will be further satisfied.
2) Imported natural medicines and cosmetics could be reduced.
3) Exported natural products could earn large amount hard currency for this country
4) Consequently, modernization of phytopharmaceutical industry will be realized and it could become a very important part of pharmaceutical industry in this country.
5) Due to the collecting, cultivating and processing medicinal plants, the employment opportunities in rural areas as well as in cities will be increased. The people's life will be improved.

The consultant recommends that the improvement of production of plant-based pharmaceuticals in Mongolia could be carried out by two steps as follows:

1) Establishment of a pilot plant with a laboratory for standardization and quality control with the help of UNIDO and UNDP.

A multifunction pilot plant can be used for production of plant-pharmaceuticals in small scale. What is more, the experimentation at pilot plant level are very necessary to scale up bench-scale research results into industrial operations. Pilot plant operation should be monitored and evaluated by using modern analytical instruments to establish optimum conditions and the quality assurance of the products.

2) Establishment of Modern phytopharmaceutical industry.

At the present time, building joint-venture company with China or Japan could be considered as a better way for

improvement and development of Mongolian modern phytopharmaceutical industry. Especially, the establishment of ephedrine industry will earn huge hard currency for this country.

C. Assessment of available infrastructure facility for production of plant-based pharmaceuticals including a laboratory for standardization and quality control

1. Available infrastructure facility for production of plant-based pharmaceuticals

There are three units producing plant-based pharmaceuticals in Mongolia.

Institute of Traditional Medicine of Mongolia only produces preparations on a very small scale for own use in its clinic department. The facility here is very simple as mentioned in chapter II.

Mongolian Pharmaceutical factory mainly produces western medicines. There is only one workshop in this factory for producing two kinds of plant-based medicines. The available infrastructure facility for production of plant-based pharmaceuticals in this factory is as follows: percolator, extractor, powder-packing machine and liquid-packing apparatus.

Research and Production Company "Shine Ekhlel" is the unique unit for producing plant-based pharmaceuticals. Twenty kinds of main plant-based medicines (see table 1) are produced in comparative large scale in this company for supplying internal markets. The available infrastructure facility for production of plant-based pharmaceuticals in RPCSE is mainly as follows:

1) cutting-grinding machine
2) ball-mill pulverider (made by the company itself)
3) extraction equipment and percolator
4) water-distillation apparatus
5) fraction distillation equipment
6) tablet-machine
7) Packing-machine

Mongolian Company of Medicinal Plants (MCMP) has some equipments for post-harvest treatment of medicinal and aromatic plants. such as cutting machine imported from Germany, cleaning machines, drying machines and rooms.

2. Available laboratory equipment for standardization and quality control

The Institute of Chemistry of Mongolian Academy of Sciences has the best laboratory equipment in Mongolia, including HPLC, GC, MS, NMR UV and IR spectrophotometers. Some scientists here are studying the active constituents of Mongolian medicinal plants. Some applied research results were transferred to the

RPCSE to be manufactured

In the Institute of Traditional Medicine of Mongolia, some equipment for research, quality control of plant-derived pharmaceuticals is available, such as HPLC, TLC apparatus.

In the laboratory of RPCSE, there are some equipments for research and quality control as follows:

1)UV/vis Spectrophotometer
2) Balance
3) refrigerator
4) vacuum dryer
5) fraction collector (for column chromatography) and TLC tanks
6) glassware

This company works in close collaboration with Mongolian Academy of Sciences (MAS). Some research works are mainly carried out in the chemistry department of MAS. The laboratory equipments in MAS are comparatively advanced. There are UV. IR. MS and NMR equipments for structural elucidation and HPLC, GC for qualitative and quantitative analysis (quality control). The RPCSE also cooperates with the Institute of Traditional Medicine of Mongolia in the field of research and quality control of plant derived pharmaceuticals.

D. Assessment of the market potential for the plant-derived pharmaceuticals both internal and external

Mongolia has more than 100 traditional Mongolian hospitals where large amount of plant-derived pharmaceuticals are used for treatment of various diseases. About 70 percent of Mongolian people believes in traditional medicine and likes to be treated by using plant-based drugs, according to the statistics of the Ministry of Health of the country. At present, the plant-derived drugs produced in the country is far from enough to satisfy the need of health care in terms of the number, volume and quality of plant drugs.

On the other hand, the animal husbandry requires even more plant-derived pharmaceuticals. For example, there are about 10 millions of sheep, 5 millions of goats, 2 millions of cattle and horses and 400,000 pigs. The total requirement of Targa per annum is about 150 tonnes. If the standardization and the quality of this product reached the international level, it could be exported abroad, especially to Australia, Canada and USA.

Glycyrrhizic acid and its preparations are used for treatment of hepatitis and are popular in Mongolia. Especially glycyrrhizic acid has vast international market as a food addictive, for treatment of stomach ulcer and Aids as well as

hepatitis. l-and d-ephedrines which can be extracted from Ephedra equisetina growing abundantly in this country have very big international market, especially in USA.

E. Recommendation of requirements for training of personnel, facilities, equipments and activities to be undertaken for the development of plant derived pharmaceuticals

In order to develop and improve the industrial extraction of indigenous medicinal plants and production of plant-derived pharmaceuticals, the consultant has written a draft project document. The project aims at establishing a pilot plant and a modern laboratory for standardization and quality control in the Research and Production Company " Shine Ekhlel" to promote the implementation of the Governmental Programme on rational utilization of local resources of medicinal and aromatic plants. The requirements for training of personnel, facilities, equipments and activities to be undertaken for the development of plant derived pharmaceuticals are recommended in details in that draft project document. Here the consultant would like to do a little explanation.

1. Training of personnel

1) Study tour for senior staff (top leader of National Project Committee) is recommended to do as follows:

(1) visit to Shenyang College of Pharmacy which is one of the biggest pharmaceutical universities in China. There is a good pharmaceutical factory which should be visited. There are many chemical engineers, technologists, professors who can discuss about the pilot plant and the technology for production of glycyrrhic acid and its preparations.

(2) visits to institutes in Shanghai and Beijing

(3) visit institutes in Japan

2) Training of chemical engineer, technologist, analyst and marketing manager is recommended to do as follows:

(1) At first, all of these persons can be trained in Shenyang College of pharmacy, in the following departments of this college: Chemical engineering department (for training of chemical engineer), pharmaceutical department and the college-run pharmaceutical factory (for training of technologist), Department of analytical chemistry (for training of analyst), Management department and export company (for training of marketing manager)

(2) Then these persons can visit some institutes, pharmaceutical factories in Beijing and Shanghai.

2. Facilities and Equipments

The provisional list of equipments is annexed in the draft project document.

The most important facilities and equipments required in RPCSE are pilot plant and a laboratory for quality control.

1) Polyfunction pilot plant

This pilot plant should have following functions: extraction, (with water and ethanol as solvents), distillation (for producing essential oil or recovering organic solvents), concentration, filtration, etc.

2) Laboratory equipments

HPLC and GC apparatus is most necessary for RPCSE to control the quality of plant derived pharmaceuticals and to analyze the essential oils.

F. Summary of conclusions

1. Laboratory scale experiments are being conducted on medicinal and aromatic plants in a few institutions such as MAS, ITMM.

2. Pilot plants for scale up studies are not available in the institutions visited.

3. Technology development and its transfer capability is weak.

4. Mongolia has a wealth of natural resources of medicinal and aromatic plants. And there is a great market potential for the herbal medicines as about 70% of Mongolian people believes in herbal medicines and like to be treated by using plant-derived pharmaceuticals.

5. Research and Production Company " Shine Ekhlel" (RPCSE), established in 1978 and now functioning under the leadership of the Ministry of National Development, has built-in some research and production infrastructure, qualified manpower, buildings, lands and headed by qualified and experienced directors with vision and dynamism. Now RPCSE is wholly engaged in conducting production of plant-based pharmaceuticals and research work in utilization of medicinal plants. But this institutions should be strengthened to meet the great demand for R & D of herbal medicines.

The mission concludes that RPCSE qualifies for UNDP/UNIDO support to set up multipurpose pilot plant for extraction, distillation and evaporation of medicinal and aromatic plants as well as a laboratory for standardization and quality control.

At the end of this project, RPCSE will become

- Experimental base at pilot plant level: RPCSE is in good collaboration with MAS and ITMM. The bench-scale research results obtained in abovementioned institutions can be scaled up in the base into industrial operations. The pilot plant at RPCSE capable of carrying out various unit operations such as extraction, distillation, fractionation, evaporation, etc. can be suitably used to derive necessary process parameters for scaling up to the industry.

- Model company for production of plant-based pharmaceuticals: At the end of this project, RPCSE will produce high quality products by using the pilot plant and the modern laboratory. This will draw strong attentions of many small plant-derived pharmaceutical factories to follow RPCSE. Thereby the Mongolian Governmental Programme on rational utilization of natural resources of medicinal plants will be greatly promoted.

- As the result, there will be a great improvement and development of phytopharmaceutical industry in Mongolia

G. Summary of recommendations

Identification of the problem	Action to be taken	Responsible party
1. Mongolia is rich in natural resources of medicinal and aromatic plants. And phyto-pharmaceutical industry has already existed in this country. But the equipments are too simple and old to produce good products. The laboratory equipments are also far from enough for quality control.	A UNDP/UNIDO project to strengthen RPCSE should be initiated. Through this project, a multi-function pilot plant for extraction and distillation should be established at RPCSE with a laboratory for standardization and quality control.	National project staff, buildings, raw materials, running cost of the pilot plant and laboratory and other locally incurring expenditure should be borne by the Government (or RPCSE). Acquisition of the pilot plant, analytical instruments, international experts and training of personnel, study tours should be covered by UNDP/UNIDO.

2.There are no factories or companies producing pure substances (effective compounds) in Mongolia, such as 1- and d-pseudo-ephedrine, glycyrrhizic acid, berberine etc.	Mongolia is very rich in Ephedra equisetina for producing ephedrines. MND can negotiate with State Pharmaceuctical Administration of China to establish a joint venture company.	Ministy of National Development of Mongolia
	Mongolia is rich in Glycyrrhiza uralensis for producing glycyrrhizic acid. RPCSE has cultivated this palnt in large scale. RPCSE should contact pharmaceutical factory of Shenyang College of Pharmacey about joint production of it.	RPCSE
3. No phyto-pharmaceutical products have been exported abroad.	Mongolia is characterized by the vast area with rich resources while very small population of two millions. So the natural resources of some medicinal plants, such as Ephedra equisetina, Glycyrrhiza uralensis etc. are more than enough for using internally. MND and companies should pay more attention to develop international markets. Such products as ephedrine and glycyrrhizic acid have very vast international markets, especially in USA, JAPAN, and EUROPE, In this field the mission would like to help Mongolia with development of international markets.	MND and export company, pharmaceutical company, RPCSE

4. Steady supply of adequate amount of plant materials to support industrial operations.	1) Systematic collection of wild medicinal and aromatic plants on a subtained yield basis should be programmed and executed.	The Government and MCMP
	2) Cultivation of medicinal and aromatic plants should be continuous and enlarged in terms of numbers and volumes of cultivated plants. Especially, RPCSE should initiate to cultivate Piptanthus mongolicus and enlarge the cultivated area for Glycyrrhiza usalensis.	RPCSE, Government, MCMP
5. There are no technologies for producing ephedrines and glycyrrhiza acid as well as its preparations	1) Technology for producing ephedrine could be transferred from China which is the biggest exporter of natural ephedrines in the world through UNIDO and SPAC. The consultant can also help with it.	MND
	2) Technology for producing glycyrrhiza acid and its preparation can be transferred from the pharmaceutical factory of Shenyang College of Pharmacy which is producing these products. The technology transfer is recommended to combine with training of technologist and engineer for RPCSE.	RPCSE, Government, UNDP/UNIDO

V. Acknowledgment

The author wish to express his sincere thanks to Mr. Ian Davies, the UNIDO Country Director-China for his good suggestions and a lot of help with arranging schedule.

Special thanks go to Mr. Tuley De Silva, the officer of Chemical Industries Branch of UNIDO, Vienna for his helpful advices that made the mission in Mongolia successful.

The author is grateful to all of the people contacted during the mission in Mongolia, particularly, Dr O. Purev of Mongolian Academy of Sciences for his assistance with the interpretation and translation from Mongolian to English.

Annex 1

Job Description

Project in Mongolia
UF/MON/91/105/11-51

Post Title: Expert in the Production of plant-derived pharmaceuticals

Duration: 1 w/m

Date required: ASAP

Duty station: Mongolia

Purpose of project:

To initiate technical assistance programme for the "Industrial Extraction of Indigenous Medicinal Plants and Production of Plant-Derived Pharmaceuticals."

Duties:

The expert is expected to carry out the following duties:

-Evaluate the present situation in Mongolia particularly the Research and Production Company "Shine Ekhlel" with respect to the possibility of producing plant-derived pharmaceuticals from indigenous plant species growing abundantly in the country.

-Assess available infrastructure facility for the production of plant based pharmaceuticals including a laboratory for standardization and quality control.

-Assess the market potential for the plant derived pharmaceuticals both internal and external.

-Recommend requirements for training of personnel, facilities, equipment and activities to be undertaken for the development of plant derived pharmaceuticals.

-Prepare a report covering his findings and recommendations and a draft project document for technical assistance for the development of plant based pharmaceuticals in Mongolia.

Annex 2

List of people met

RPCSE
53 Zaisan, Ulaanbaatar
Telex: 236 CNTIMH
Tel: 3-42812; 3-42310

Dr. J. Miagmar, General director
Mr. J. Baatar, Deputy director
Mr. O. Bat-Erdene, Deputy director
Dr. O. Purev, Scientific advisor.
Mr. S. Mamchu, Head of phytochemical laboratory

UNDP
P.O.Box 49/207,
Ulaanbaatar, Mongolia,
Tel: 27585, 321539; Fax: 893-150-7441

Mr. Gombosuren GANKHUYAG, Programme assistant.
Mr. Shun-Ichi Murata, Deputy Resident Representative.

ITMM
20, Ulaanbaatar, Mongolia
Tel: 329722

Mr. D. Magsar, Scientific secretary of ITMM
Ms. Ulaaeebaatar, Doctor and Researcher.

MAS
Ulaanbaatar-51, Mongolia
Tel: 53133

Mr. D. Badgaa, Prof. Dr. Member of MAS, Director of the chemistry institute MAS.
Mr. D. Gantimur, Dr. Scientist researcher of Chemistry institute.
Mr. O. Purev, Dr. Scientist researcher of chemistry institute
Mrs. D. Selenghe, C. Sc. Scientist researcher of chemistry institute

BCM
Songino Ulaanbaatar, Mongolia
Tel: 26648

Mr. G. Tumurchaduur, Vice director of the Biokombinat Company, Candidate of veterinary science
Mr. B. Sodnam, Head of Department for biological preparation

MCMP
Ulaanbaatar-24
Tel: 60680

Mr. R. Baatar, General director of MCMP
Mr. Ser Od, Manager of MCMP

MPF
Ulaanbaatar, Mongolia
Tel: 21400; 65887

Mr. S. Tsendsuren. General director of MPF
Ms. S. Baljin, chief engineer of MPF

CLBPD
Ulaanbaatar, Mongolia
Tel: 29332

Ms. D. Kalima, Director of CLBPD
Ms. B. Lantuya, Chemist of CLBPD.

SMRI
Ulaanbaatar, Mongolia,
Tel: 23852

Ms. Z. Ojungered. Chief of SMRI
Ms. L. Cerendulam, Senior researcher

MPC
Ulaanbaatar-28 Iks Toirog-39, Mongolia
Tel: 323877; 56461, Tlx: 79222, Medic MH

Mr. R. Byambaa, MD, Ph. D. General director of MPC

TMH
P.O.Box 36/4, Ulaanbaatar, Mongolia
Tel: 342151; 341905

Mr. T. Sukhbaatar, Vice director of TMH (Balneology Center)
Cand. Med., Sci. Senior Scientist
Ms. J. Dashichenaa, Doctor of TMH.
Ms. C. Dolchersuren, Doctor of TMH.

MND(NDB)
Ulaanbaatar 46, Mongolia, Tel: 20708

Mr. J. Khurelsukh. Director of Department of Technology and Investment Policy of NDB.

MMU(NMUM)
P.O. 48 Box 60, Ulaanbaatar, Mongolia
Tel: 21834, 20014

Mr. D. Dungerdoji, vice-president of MMU.
Mr. T. Khaidav, consultant-Lecturer of the department of Mongolian Medicine of MMU, Academician. doctor of medicine.
Mr. C. Batmoih, Director of the Department of Pharmacy.

Annex 3

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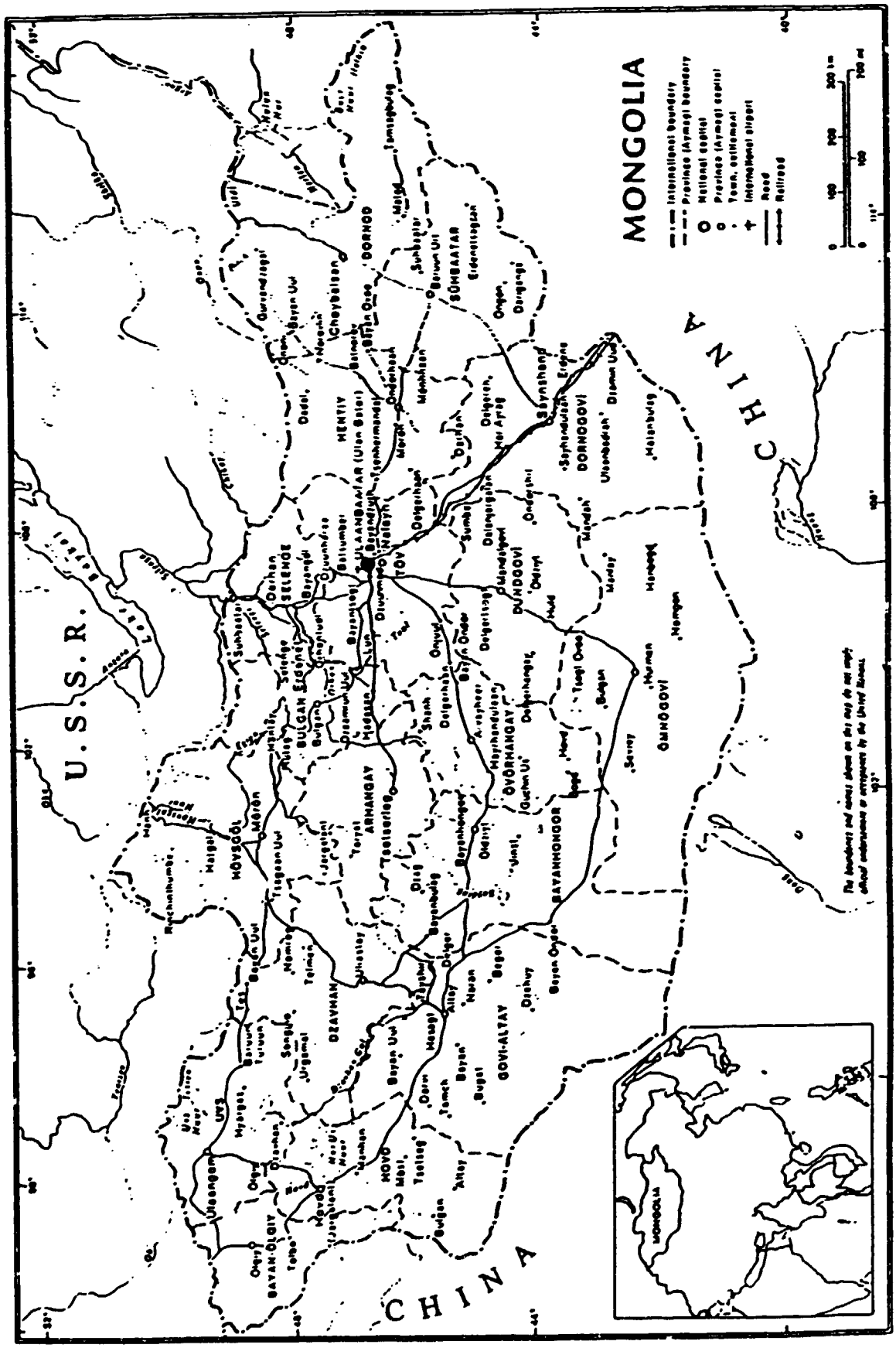
Annex 4

PHOTOGRAPH OF PRODUCTS MANUEACTURED BY RPCSE

Annex 5

MAP OF MONGOLIA



Annex 6

Backstopping Officer's Technical Comments
based on the work of Mr.Ying-Jie Chen
UF/MON/91/105/11-51

The report contains a detailed account of the Consultant's activities and findings. Based on these he has made valuable recommendations for the development of the plant-based pharmaceutical industry. He also has researched the requirements for technical assistance and drafted a project document. The potential for the industrial use of plant resources in Mongolia is well evaluated and should attract the urgent attention of the Government and the project counterparts. UNIDO could use its experience and expertise to assist in the development of the subsector. Many recommendations can be executed as an initial stage of the process of product and quality improvement. The need to systematically cultivate and sustainably harvest wild species has been stressed. The possibility of cooperation with institutions in China has been mentioned. It is hoped that the Government will officially request technical assistance from UNIDO to execute a project as outlined in the draft project document.