

Sustainability of Chinese Medicinal Herbs: Developments

Abstract

This article discusses the current challenges in the production of Chinese medicinal herbs in China and how they have developed in recent years, in particular the dramatically increasing excess of demand over supply for many herbs and the decline in or inconsistency of quality of many cultivated herbs as well as wild-gathered ones. It also looks at ideas and initiatives to tackle these problems.

By: Nina

Zhao-Seiler

Keywords:

Chinese medicinal herbs, Chinese medicine, quality, sustainability, cultivation, wild gathering, half-wild cultivation.

Introduction

As practitioners of a medical system like TCM, that emphasises interconnectedness and the strive for a harmonious relation between humans and their environment, most of us are concerned with sustainability in general and in particular regarding our own medicine. Three years have passed since my article ‘Sustainability of Chinese medicinal herbs: a discussion’¹ was published in this journal. Three years might not seem a long time, but for the development of medicinal herb production in China it is enough time for big changes.

The main challenges I had then identified, following the strong and steadily growing demand of the past years, were: 1) the drastic increase in endangered species and species close to extinction among medicinal herbs due to over-harvesting in the wild, along with insufficient incentives to develop cultivation methods for those species; 2) herbal materials on the market lacking reliable identity testing, resulting in different species being mixed together, as well as - in certain cases - a problematic species being used undetected, and 3) lack of traceability back to the field. The overuse of agrochemicals was only starting to become an issue. Other, more mechanical techniques to forcefully increase income in the medicinal herb trade were much more frequent then, for example selling Ren Shen (Ginseng Radix) roots a second time after their ginsenoside had already been extracted, soaking Jin Yin Hua (Lonicerae Flos) and other light medicinals in salt or sugar water to increase their weight, or imbedding nails in Tian Ma (Gastrodiae Rhizoma) for the same purpose.

So what has changed?

Pressure on wild growing medicinal herbs continues to be a very serious problem, with around 80 per cent of medicinal herb species still being collected in the wild and a constant shortage of supply for

these herbs.² Protection efforts have not been able to prevent an aggravation of the problem, with yet more medicinal herbs coming close to being endangered. Meanwhile the volume of Chinese medicinal herbs being cultivated has strongly increased.³ Due to the intensified industrialisation of agriculture and the frequently unsystematic use and overuse of agrochemicals in China, a large part of these cultivated medicinal herbs test with excessive levels of herbicides, pesticides or other polluting residues. Serious importers of TCM (Traditional Chinese Medicine) medicinals in Europe are now testing for over 500 different agrochemicals⁴ and more are regularly being found and added to the list.⁵

To summarise these changes I would like to quote an article published in May 2015 in the *Chinese Journal of Chinese Materia Medica* (translated from Chinese by myself):

‘... the past 20 years ... have led Chinese medicinal herbs into the “era of fast growth” by herbs being harvested and brought onto the market before they have reached maturity, into the “era of high productivity” through the abuse of plant-growth regulator substances [plant hormones] to increase harvest weight, into the “era of chemical industry” through the abuse of noxious substances on the herbal material, and into the “era of unified goods” through quality grading and traditional paozhi-processing being abandoned.

All of this adds up to difficulties in warranting the quality of Chinese medicinal herb material, loss of essential traditional knowledge about Chinese medicinal herbs, natural resources aching under immense pressure and other problems that severely restrict the further development of the Chinese herbal medicine professions, creating the urgent need to adopt appropriate measures that enable improvement.’⁶

This passage highlights some of the most important problems concerning sustainable growth and production of Chinese herbs. For a better understanding of this extremely difficult situation some background information is useful.

Some facts and figures about the Chinese economy

Although I have sought multiple and reliable sources for every figure cited in this article, I would like to clarify here that they are all to be considered approximations and should not be taken as absolute. Amongst other reasons, for a country with an internal market the size of 25 per cent of the world's population, no figure can be absolute. The TCM medicinal segment, being part of the Chinese healthcare industry, has so far been less affected than others by the overall slowing down of Chinese economic growth, which realistic estimates see at around five to six per cent for the year 2015.⁷ However, this figure does not show the immense differences between sectors. Heavy industry, for example, is shrinking, whereas the service sector, including healthcare, is growing by more than 10 per cent.⁸ In the past three years I have met several people who personify this shift, who come from heavy industry and have started to engage in the cultivation or half-wild cultivation of Chinese medicinal herbs.

In the Chinese medicinal sector, both the herb-growing industry and the herb-manufacturing industry have been growing in value at a rate of 10 to 20 per cent for approximately the last eight years and are expected to continue growing at the same rate.⁹ Within China alone revenue is approximated at 22 billion US dollars for the herb-growing industry and 28 billion US dollars for herbal medicine manufacturing for the past year according to Ibisworld.¹⁰

According to the Chinese National Bureau of Statistics, the total revenue of the Chinese traditional medicines industry is worth about 31 per cent of the total Chinese pharmaceutical industry.¹¹ As a comparison, herbal medicines in general (including Chinese herbs) are worth only 3.5 per cent of the total pharmaceutical industry in Germany.¹² About 20 per cent of the medicinal herbs harvested in China goes into export, almost exclusively as raw herbs. However, this constitutes only a quarter of the global value of the Chinese herbal medicine market, since value is generated in large part by processing and manufacturing raw herbs into medicinal (for example granules) and food products, and cosmetics.¹³

When talking about sustainability in the production of Chinese medicinal herbs we should be aware of the economic frame described above. As in the previous sustainability article, I am mostly concerned with describing the circumstances of herb growing and gathering. However, knowing that there is a very large manufacturing industry stimulating a domestic demand

of herbs that exceeds international demand by far¹⁴ is important in order to understand the developments in the Chinese herb growing industry of the recent years.

In the past 20 years, the overall supply of herbal raw material has never been enough to meet demand. Even more so in the past 10 years, since the boom in the cosmetic and health food industries, which are now competing with yin pian¹⁵ producers and patent medicine manufacturers for the herbal raw material. There is a general severe and worsening shortage of herbs gathered in the wild. For cultivated herbs the shortage is not constant but fluctuates, with some herbs having a seasonal surplus. For both wild gathered and cultivated herbs the problem of declining and inconsistent quality is severe. Factors contributing to these problems include: increasing demand in China as well as globally; strongly fluctuating market prices (which make it very hard for farmers to plan) due to the seasonality of herb harvest, but also to poor coordination and poor planning of the amount of herbs cultivated; unreliable quality of herbal raw material due to overpicking and picking of immature plants in the wild; and the increasing use of agrochemicals and artificial fertilisers in cultivation.

Within China alone revenue is approximated at 22 billion US dollars for the herb-growing industry ...

On the manufactured product side the main difficulties are: very large competition¹⁶ and a fierce price battle in the market for patent medicines. Since in China processed herbal medicines are considered necessity goods, the government intervenes by exercising price controls to keep their prices low, while herbal raw materials are considered an agricultural product the price of which is solely defined by market demand. These factors combined have pushed some high quality products out of production and conversely, to a certain extent, have encouraged low quality products. Meanwhile, the Chinese State Food and Drug Administration (SFDA) has also been forcing a number of low-end manufacturers of Chinese medicinals to close, due to their failure to meet quality standards in their production process.¹⁷ It has also been working on implementing tighter quality and safety controls and higher thresholds for the registration of new medicines, as well as for GMP (Good Manufacturing Practice) registration for herb processing companies¹⁸ in an effort to raise the quality standard of medicines.

There will be still more consolidation in the market, leaving fewer and bigger companies producing on an industrial scale. This could make quality and safety controls easier. It will also make it harder for small manufacturers to stay in business, even if their products

are of very good quality, a trend that we know all too well from Europe.

What does this mean for sustainable Chinese herbal medicine production?

In the past three to five years we have been witnessing an overall decrease of medicinal herb resources in the wild by 30 per cent a year, due to the dramatically increasing gap between the ever-growing demand and a steadily decreasing supply. This is partly due to increasing Chinese national and international demand but also due to reduction of dried herbs in storage.¹⁹ With 80 per cent of medicinal herb species (accounting for around 40 per cent of herb volume) continuing to be mainly gathered in the wild and cultivated medicinal herbs (accounting for around 60 per cent in volume) increasingly being the subject of reported pollution,²⁰ the urgent necessity to improve the situation is clear. Many concerned, learned and industrious agronomists, pharmacognosists, farmers, community leaders and others are working on solutions ranging from research into domesticating wild herbs, to developing standards for the cultivation of specific herbs, education and counselling of farmers on reasonable use of fertilisers and agrochemicals, Good Agriculture Practice (GAP) and Good Manufacturing Practice (GMP) standards, and promoting half-wild cultivation with investors who have enough funds to finance such long-term projects. Some efforts are more 'rules and regulations' oriented, seeing solutions in more sustainable²¹ - that is, farsighted - planning and nationwide implementation of these plans. Others look to the improvement of quality emphasising market consolidation, survival of the fittest and the initiative of farsighted entrepreneurs, who sense the opportunities offered by the growing wellness sector and are able to take advantage of them in a considerate - that is relatively sustainable - fashion. The challenge with the former approach is implementation, whilst with the latter it is the likely loss of many less prominent and therefore less lucrative herbs as medicinals.

Just as in Europe, the requirements to legally sell a food or a wellness or cosmetic product in China are much fewer than those to legally sell a medicine. One of the reasons why the official list of medicinal herbs that are also classified as foods has been extended - to now include 115 items - is to give producers of Chinese herbal raw material an incentive to take on the challenge of investing on a larger scale. The income that can be generated by cultivating herbs that are not rare or otherwise especially asked for (and therefore yielding a higher price like, for example, Chong Lou [Paridis Rhizoma] or Ren Shen [Ginseng Radix]) but that are very needed in daily practice, such as Fu Ling (Poria) or Jie Geng (Platycodi Radix) is little to none - especially when following GAP standards²² - if these herbs can only be sold as herbal medicine raw material.²³ This is one of the reasons why some herbs, while their cultivation

is possible, are still gathered in the wild: no investment is needed.



Weighing Chuan Xiong (*Ligusticum chuanxiong*) sprouts in Pengzhou, Sichuan. Copyright: Nina Zhao-Seiler

Current situation

Wild gathering

An increasing number of Chinese medicinal herbs are threatened or close to extinction in the wild.²⁴ Some of the commonly used herbs that are still mostly gathered in the wild include Ji Xue Teng (*Spatholobi Caulis*), Lian Qiao (*Forsythiae Fructus*), Hu Zhang (*Radix et Rhizoma Polygoni Cuspidati*) and Yi Mu Cao (*Leonuri Herba*).²⁵ Chai Hu (*Bupleuri Radix*), Gou Teng (*Uncariae Ramulus cum Uncis*) and many others have been decimated to a critical extent by excessive gathering in the wild, which still carries on now, even though their cultivation is possible and has been taking place for years.²⁶ Gan Cao (*Glycyrrhizae Radix*) and Fang Feng (*Saposhnikovia Radix*) are also among those herbs that are gathered in the wild, even though their cultivation is possible. Wild gathering of Gan Cao has been declared illegal. At the moment there is still an interim period in which a certain amount of wild gathered Gan Cao can be accepted by herb wholesalers. It is now also imported in large quantities from neighbouring Kazakhstan, Kyrgyztan and other neighboring countries where apparently there are still more resources in the wild and/or less control.²⁷ The reduction in natural resources of Gan Cao in past years has been particularly severe and detrimental, not only to the natural resource of Gan Cao but also for the environment by promoting desertification: the gathering of one Gan Cao plant destroys around 10 square metres of plants growing near it as they are pulled out of the sandy soil together with the Gan Cao roots. The reasons for this is that Gan Cao roots not only grow deep vertically but also horizontally in a wide diameter around the plant - which is precisely why they can halt desertification when left intact. Another example is Ma Huang (*Ephedrae Herba*), through the gathering of which 3,200 hectares of meadow are destroyed every year.²⁸ The cases of both Ma Huang

and Gan Cao show how wild gathering in the traditional way, that is without plan and set recovery times, may have worked well in earlier times when resources were more ample, but does not work in today's environment. High population density and a high demand for the herbs render it no longer viable, even though there are still many people living close to these natural resources who have grown up with the tradition of gathering as an additional income.



Digging out field-cultivated Gan Cao (*Glycyrrhiza glabra*) roots, Baotou, Inner Mongolia. Copyright: Rudolf Rinder, Bavarian State Research Centre for Agriculture

A different example is that of non-traditional wild gathering, as in the case of Hong Dou Shan (*Taxus chinensis*). This tree used to be common but when the anti-cancer properties of one of its ingredients (taxol) were discovered in 1967, it started to be gathered and is now nearly extinct in the wild.

In my opinion, the established practice of the solitary gatherer, who makes money solely according to how many herbs they deliver, must be changed if wild gathering is to be transformed into a sustainable method of sourcing medicinal herbs today. Such a change could come about through involving gatherers in conservation work by making the combination of gathering and conservation a communal responsibility. Gathering and conservation should be made into an attractive activity, with an individual income based on the ecological condition of the lot that a person is responsible for.²⁹

Cultivation

Today - that is in 2016 - around 200 species of Chinese medicinal herbs can be cultivated; of these, 100 are under large scale cultivation, the other 100 are being grown on a smaller scale; together they yield around 60 per cent of the total yearly market demand in China.³⁰ Some herbs like Ren Shen (*Ginseng Radix*), San Qi (*Notoginseng Radix*) and Bai Zhu (*Atractylodes macrocephala* Rhizoma) are now completely extinct in the wild³¹ and therefore exclusively produced by cultivation. A lot of progress has been made in defining/refining cultivation methods

and standards for individual herbs, and some milestones have been reached. Domesticating a herb growing in the wild, let alone cultivating it large scale, can be extremely difficult. An example showing the complexity of such procedures is the cultivation of the orchid Tian Ma (*Gastrodia Rhizoma*), which has become possible only after understanding its symbiosis with two different fungi. Only when in contact with both of them, each in the right amount, will Tian Ma grow its flowering stem and reproduce. Much more research on the individual needs of each herb in terms of type of soil, fertiliser, symbiotic plants (as in the case of Tian Ma), optimal growing times and so on is under way in China; much is still unknown. This type of research takes time, like in the case of Chuan Bei Mu (*Bulbus Fritillariae Cirrhosae*), on the cultivation of which one professor of Sichuan University has worked for the last 50 years up in the highlands near Songpan, Sichuan. He is now 80 years old and the cultivation of Chuan Bei Mu has only just become possible in the last couple of years, which represents another milestone. It can take a lot of effort to give a wild seed the exact environment it needs (soil, temperature fluctuation, humidity, light-time, etc.) in order to start germinating. Bit by bit, over the course of many years of patient observation and trial and error our knowledge and understanding about these needs increases. But relatively little of this knowledge has so far found its way into the practice of field cultivation of herbs. For most producers, investing many years into research about the special needs of individual herbs is too expensive. Who can afford to spend a lifetime on research? Many farsighted farmers and herb producing companies have some trial beds alongside their fields where they keep working on better methods, more fitting breeds or the cultivation of wild herbs. Investing in research on a larger scale is risky. A year ago I visited a herb company that had invested a lot of money into the breeding of a variant of Shan Yin Hua (*Lonicera macranthoides*) that would be easy to pick, thereby substantially lowering production costs. In its 2015 edition, the *Chinese Pharmacopoeia* established that Shan Yin Hua, previously considered a subtype of Jin Yin Hua (*Lonicerae Flos*), was to be listed as a separate entry, making it much harder to sell.³² This company had to go out of business.³³

The established practice of the solitary gatherer, who makes money solely according to how many herbs they deliver, must be changed if wild gathering is to be transformed into a sustainable method of sourcing medicinal herbs.

Most small producers do not have any formal training in the field of medicinal herb cultivation. If they live in an



One year old Song Bei Mu (*Fritillaria unibracteata*) sprout (top quality species used to produce Chuan Bei Mu [*Fritillariae chirrosae Bulbus*]). Copyright: Rudolf Rinder, Bavarian State Research Centre for Agriculture

area with a long tradition in the cultivation of a certain herb, a so-called Daodi area,³⁴ then they have usually received the knowledge gathered over the centuries, but this does not inform them on the use and perils of modern agrochemicals and fertilisers. Outside their Daodi area of cultivation, herbs are even more likely to be regarded as 'just another crop.' This neglects the fact that herbs are medicines, not fruit or vegetables, and what we need from them are not their so called primary metabolites, which are proteins, fats or sugars, but their 'secondary metabolites', which are substances they produce for their defence and other substances that define their medicinal properties. These are not usually enhanced by prompting the herb to grow as fast and as big or even as beautiful as possible. In an area where medicinal herb cultivation is done much like the cultivation of a food crop, herbs will more likely be pushed to the limit of growing speed, size and external impeccability - and given up as soon as other crops seem more financially sustainable, which is quite often the case. In Guangdong province, for example, the cultivation of He Shou Wu (*Polygoni multiflori Radix*)/ Ye Jiao Teng (*Polygoni Multiflori Caulis*) has gone down by 90 per cent because growing fruit trees was more profitable for farmers.³⁵ This type of flexible adjusting is in fact important in such fluctuating market conditions, since it can help farmers level out sharp price jumps. It does not however, encourage careful high quality production.³⁶ Even in some Daodi areas the investment necessary to cultivate high quality herbs, (which involves not over-pushing them with excessive use of plant hormones and fertilisers, as well as not over-protecting them with excessive use of pesticides, while applying mechanical instead of chemical weed control), is often too high and the income too little to motivate farmers to continue growing the local speciality herbs. The patience needed to grow good quality herbs also requires money available to live on while waiting for the crop to mature and get ready to be harvested.

Areas with large monocultures of genetically uniform

plants are often more economically sustainable because they can be worked on more efficiently and GAP criteria are more easily met. At the same time they also pose an increased risk of diseases spreading, as stated above, precisely due to their uniformity. This risk can be heightened if there is too little crop rotation.³⁷ Crop rotation, again, costs time without harvest, that is without income. Agriculture counselors specialised in the cultivation of medicinal herbs are not available to all farmers. So lack of formal training, and therefore lack of understanding of the overall effect of agrochemicals, as well as lack of financial backing are the main reasons behind the misuse of agrochemicals and the ensuing pollution, which have now escalated into a problem of massive proportions. Lack of specific knowledge also concerns heavy metal accumulation in medicinal herbs. This is an area where as yet not much knowledge is available. Research is underway, but so far much remains unclear about the physiology of particular medicinal herbs that tend to accumulate certain heavy metals, even if their amount in the soil is not especially high.³⁸ In addition, concentration of heavy metals can indeed be excessive in certain soils due to industrial pollution, for which reason soils should always be tested before starting new cultivation. This is something that any serious investor in Chinese herb cultivation will nowadays do (but, alas, not everyone is serious).³⁹

Another area of growing concern is the problem of genome diversity and seed production. As of now, of the 200 herbs under cultivation, only 20 are being artificially bred.⁴⁰ Many are propagated by vegetative reproduction, which means all the plants are offspring of one single plant and share exactly the same genome. If this is done on a small scale you get 'homegrown' species, different from farm to farm. If it is done on a large scale and intensively in the end you get a uniform product, the 'correct' species we keep asking for, but there is also a higher risk of spreading plant diseases and also of further losing genome resources. For many other cultivated herbs, seeds are still gathered in the wild, making stable recovery of wild resources more difficult. So while cultivation is taking off some of the pressure from some of the wild resources, a lot of work remains to be done. Protecting the biodiversity of Chinese medicinal plants is a difficult task.

There are of course model projects that fill a herbalist's heart with joy, such as that of the retired geologist developing his own methods of organic herb cultivation in the secluded valley north of Huhehaote in Inner Mongolia, and the young family father who had to give up his studies at the best medical university in the country due to a debilitating injury and instead started cultivating medicinal herbs on his home farm. He is also experimenting on his own and is already growing wonderful Chai Hu (*Bupleuri Radix*), Huang Qin (*Scutellariae Radix*), Xiao Qin Jiao (*Gentiana dahurica Fisch.*)⁴¹ and black Gou Ji Zi

(*Lycium ruthenicum* Murr.)⁴² without any agrochemicals, using only manure from his own farm as fertiliser. Or the two young entrepreneurs who left the food industry to start their own Gan Cao (*Glycyrrhizae Radix*) cultivation business in the region east of Baotou, Inner Mongolia, who are making very farsighted and careful plans to keep their project sustainable. They are all examples of the growing 'back to nature' current within Chinese society. Another is the community in Santai, central Sichuan, where the village mayor established a Mai Men Dong (*Ophiopogonis Radix*) production collective and set up agricultural counselling and cultivation classes for everyone interested, to encourage the inhabitants of his community to take advantage of their being part of the Mai Men Dong Daodi area. There is also the perfectly managed company in Pengzhou, western Sichuan basin, Daodi area of Chuan Xiong (*Chuanxiong Rhizoma*). They were one of the first to receive GAP standard recognition around 14 years ago and still maintain it to date; they continuously and patiently educate locals about the details of GAP standard, enabling them to participate in the project if they want to. Yet another example is the old farmer with his wife in the mountains above Hanyuan in Sichuan who, in the last 60 years, has been experimenting with the cultivation of Shi Hu (*Dendrobii Herba*) on all the rocks in a radius of about 100 metres around his home and has by now inspired the whole village to grow Shi Hu, making a beautiful sight when approaching! Innumerable stories of people taking care of and further developing the precious heritage of cultivating and making medicinals with Chinese herbs.

The fields of Jiangyou, northern Sichuan Basin, the old (but not the first) Daodi region for Fu Zi (*Aconiti Radix lateralis preparata*), one of the hotspots of the herbal industry, is yet another, more famous example. Here it becomes particularly obvious how diverse the currents of the 'back to nature' movement are. Radical traditionalists, who peel their roots with wooden knives, work next to producers who use chemical peeling, and do not worry about using herbicides since, they say, the leaves of the aconite, after all, are not the crop. The spectrum goes from people who are very concerned with sustainable production all the way to people who consider the name of Jiangyou, as the Daodi Region for Fu Zi, enough of a guarantee for the quality of the natural product.

A word about organic farming: organic standards have been developed for the production of food crops. Even though organic farming is concerned with sustainability, medicinal herbs have to be approached from a different point of view. As explained above, a good quality organic vegetable does not have the same qualities as a good quality medicinal herb. So, yes, trying to follow organic standards in the cultivation of herbs is definitely not a bad idea but it does not guarantee a good quality herb. For that a lot more needs to be taken into consideration and might

sometimes be even more important, like for example location, the specific needs of the plant (for example Bai Ji [*Bletillae Rhizoma*] grows well under *Osmantus* trees), the time needed to grow and the time left between crops.

Radical traditionalists, who peel their roots with wooden knives, work next to producers who use chemical peeling ...

Half-wild cultivation

Half-wild cultivation or natural fostering as a concept is relatively new in the production of Chinese medicinal herbs. In Europe no such concept of herb cultivation has been developed. It could be compared to the methods of reforestation. Its core idea is to increase the number of plants in their native habitat by giving them support in the first phases of their life cycle, for example by spreading seeds or even planting seedlings and watering them initially, depending on the approach, while interfering as little as possible with the natural course of their growth later on. This production model comes closest to a sustainable way of producing medicinal herbs, both in terms of preserving natural resources and in terms of the quality of the harvest. In their article on sustainable production, Li Xiwen et al. (2015) have described examples of Huang Lian (*Coptidis Rhizoma*), Chuan Bei Mu (*Bulbus Fritillariae Cirrhosae*) and Gan Cao (*Glycyrrhizae Radix*) production with the natural fostering method, yielding plants that were very close to good quality wild exemplars and, in addition, the biodiversity of the environment they were grown in was increased. In the Huang Lian natural fostering project they describe, even the amount of money invested was less than for a comparable size project with conventional cultivation.

Although natural fostering is a very attractive method, fulfilling by definition the ecological aspect of sustainability, one thing that has to be taken into consideration is that plants grow slower and often stay smaller in natural fostering than on a fertilised, weeded and irrigated field. This means that the actual amount of money invested may be lower, the time span in which the investment does not yield is longer and, depending on the crop, the income itself lower due to the harvest weighing less. For Huang Lian the natural habitat is the forest, for Chuan Bei Mu the Tibetan highlands and for Gan Cao the desert. In the case of Huang Lian it might not matter if it takes longer when it is grown in the forest, because no other crops would grow under the trees anyway; the same caretakers can work on the forest as well as on the Huang Lian and there might not be much extra infrastructure needed. However, in the case of Gan Cao the story is very different. Here, successful natural fostering might mean digging a well in the desert for the caretakers (who exclusively protect

the Gan Cao field, since there is no other crop) and the seedlings, maybe even building a fence for protection against the theft of the Gan Cao, all this being quite a costly investment, and then having to wait for up to 10 years before getting anything out of it. Investors have to be able to wait for a very long time without a guarantee that they can even get back the capital they invested. I visited a newly leased natural fostering area in the small Kubuqi desert in northern China, where a local entrepreneur pulling out of the coal mining industry wanted to invest some of his money in a green project and so decided to invest there in the natural fostering of Gan Cao. His agricultural counsellor told me this was at the very least an eight-year project before some decent Gan Cao would be ready to be taken out of the ground. That is a time span most entrepreneurs would not want to or not be able to wait before their investment pays off. So, in order to fulfill the purpose of encouraging local people to grow herbs in an ecologically sustainable way, this method needs to be combined with other simultaneous projects that generate more income, so as to include the two other aspects that define sustainability, which besides the ecological side are economical and social sustainability.⁴³ One possibility are tourism-projects such as the one already running in Inner Mongolia, where some communities have successfully developed and promoted a tree festival around a specific tree grown in their area. Since this festival was promoted, the natural resource of this tree, which is the source of a traditional Mongolian medicinal, has been able to recover. It has become profitable for local people to plant and foster these trees in their natural habitat. Similarly a Rou Cong Rong (Herba Cistanches)-rejuvenating festival around the natural fostering of Rou Cong Rong in the region where it occurs naturally is an idea voiced by Li Minhui of the Medical College of Baotou.⁴⁴ This would enable the local communities to generate income through visitors who could come and observe the growing plants while enjoying 'super-food' and other beneficial products made using Rou Cong Rong.⁴⁵



Huang Lian (*Coptis sinensis*) grown in the forest with shading (close to half-wild cultivation), Shizhu, Chongqing. Copyright: Rudolf Rinder, Bavarian State Research Centre for Agriculture

Definitions of sustainability

The term 'sustainability' comes from the concept of sustainable development, which has been defined by the Brundtland report (UN, 1987) as follows: 'development which meets the needs of current generations without compromising the ability of future generations to meet their own needs.'⁴⁶ The 2005 World Summit on Social Development introduced the 'three pillar concept of sustainability', which consists of the ecological, economical and social components of sustainability, clarifying how the three are interdependent, with social and economical development happening within the environment and its development.⁴⁷

'Sustainable development' and 'sustainability' are nowadays used as synonyms. Beside the three pillar concept there are now numerous other definitions, such as the one pillar-concept, which lays its main focus on ecology, and the integrative-concept, which does not make a division between different pillars. In addition, a basic distinction is conceived between strong and weak sustainability. 'Strong sustainability' regards natural capital (i.e. water, soil, air, biodiversity) and artificial (or human) capital (i.e. machines, buildings, knowledge) as non-mutually interchangeable, while 'weak sustainability' regards these resources as interchangeable.⁴⁸

Other ideas

Many different avenues are being explored to relieve pressure on herbal resources in the wild and to raise the quality of cultivated herbs, in the hope of re-establishing a sustainable supply of these treasured Chinese medicinal herbs. Such avenues include the installation of nature reserves to allow plant populations to recover.⁴⁹ In a vast country like China implementation of such nature reserves can be a challenge, as in Inner Mongolia, for example, in some places even coal mines were opened within nature reserves while no one was looking.⁵⁰ Nevertheless, plant populations did recover.

There is also the idea of using the established concept of Daodi medicinals as herbs of high quality from specific geographic regions where climate, soil and local production expertise is especially suitable for each particular herb, and combining this with more modern quality-enhancing concepts, for example specific knowledge about seed selection, germination, intercropping, harvest point, drying procedure and paozhi procedures. Such research and development is interdisciplinary and examines 'traditional' concepts of quality as well as new ideas.⁵¹ This could result in the establishment of modern standards for the production of individual herbs, based on both traditional and modern scientific knowledge.



Jie Geng stalks (*Platycodon grandiflorum*) in field-cultivation, Chifeng, Inner Mongolia. Copyright: Rudolf Rinder, Bavarian State Research Centre for Agriculture

Maybe a modernised concept of ‘Daodi Yaocai’⁵² as described above could be a way to go. This could be a vehicle for the incorporation of standardised production guidelines (like GAP and GMP⁵³) and specific modern scientific knowledge into the vast field of traditional knowledge. The latter includes definitions of good quality, which are already part of the Daodi concept. These concern each individual medicinal herb and the medicinals derived from it and are based on experiences gathered and passed down through history. In the described concept, the ‘old’ knowledge is taken as a real value and the learning process is going both ways, not just from prescientific to scientific knowledge, so as to avoid loss of relevant information.

How are we affected as users of Chinese medicine herbs outside of China?

What we have probably noticed the most is the increase in Chinese medicine herb prices in the past six to eight years. Some herbs have had sharp increases but then again there have been some sharp decreases as well (we tend not to notice those as much). All in all we might have observed the instability of herb prices. Some prominent examples are Jin Yin Hua (*Lonicerae Flos*), Ban Xia (*Pinelliae ternatae Rhizoma*) and Bai Zhu (*Atractylodis macrocephalae Rhizoma*), the prices of which have fluctuated significantly. We are affected by that to a certain extent, but since the larger part of the price we pay does not go to sellers in China but to pharmacies and importers in our own countries, the differences are smaller for us. What is more important to realise is that if a herb is temporarily not available we might do well to try and find out the reason for that and maybe replace it with another herb instead of going to another importer. It might be that there is a problem with this herb, be it pollution or scarcity. It might therefore not be such a good idea to buy it from someone who cannot prove their sources well.

Besides raising awareness of the problem of sustainability in the production of Chinese medicinal

herbs with our importers, letting them know that we care and are willing to pay for better quality with a transparent supply chain, we can also start growing some of the herbs in our own countries. Of course, this is limited to those medicinal plants that can adjust to our climate and soil, but it may still be a helpful endeavour. Helpful not only because it helps us understand the plants behind our medicinals, but also because over time this will add to the collective knowledge and experience of the cultivation of these herbs. Experience gathered trying to make the best use of technical and biological weed and pest reduction in an environment with high labour cost, while trying to avoid agrochemicals will be especially valuable. There is a need for this experience. Growers and cultivation counsellors that I have spoken to in China clearly welcome such endeavours. Being able to actually produce the finished TCM medicinal from the cultivated herb takes a few more steps. It does not just involve growing the plant, but also enabling it to grow with the desired quality, then drying and cutting it in the appropriate way, and in some cases soaking, steaming, baking or stir-frying it, all processes that we know as paozhi. In Europe an example of such a project is the Medicinal Herb Working Group of the Bavarian Agriculture Department with their research on the cultivation of Chinese medicinal herbs.⁵⁴ They have been working on standardising the cultivation of around a dozen Chinese medicinal herbs since 1999.

For Huang Lian the natural habitat is the forest, for Chuan Bei Mu the Tibetan highlands and for Gan Cao the desert.

The most pressing questions concerning herb cultivation are not the same in every country: in China the key issues are dealing with lack of supply, instability of market prices, lack of up-to-date quality standards (and therefore many more difficulties with quality control) and low end-product prices. In Germany, as well as in other Western countries, the issue is lack of experience and familiarity with TCM medicinal plants in general, and in particular with their cultivation and processing in order to use them as effective medicinals. Personally, considering the above, I think that while the most pressing questions are not the same, there is definitely great potential to learn from each other.

A little History

After all this I would like to add a little history, to give readers a glimpse of at what point in its evolution the cultivation of Chinese herbs in China stands today and to make sure I avoid giving the impression that cultivation is just beginning to be practised now. I have chosen a few details, while trying not to get into lengthy historical listings.

The oldest extant records of the cultivation of a medicinal plant dates back to the oldest written Chinese texts of all known to date, the oracle bones. Here Yi Yi (Ren - Coicis Semen) is mentioned, including its collection from swamps and subsequent planting in a field, its harvest, its processing and it being brewed into an alcoholic beverage.⁵⁵ Sun Simiao in his Qian Jin Yi Fang (Supplement to Important Formulas Worth a Thousand Gold Pieces, around 652 CE) included detailed descriptions of the cultivation methods for many medicinal herbs. At the beginning of the last century, during the Republican time, modern science and technology, including modern biomedicine, were intensively introduced and spread in China. The reputation of Chinese medicinal herbs sank, as they were viewed as being part of the old, premodern sciences, the attachment to which had contributed to the Chinese inability to throw back European and Japanese imperialistic attacks in the previous years. At that time the cultivation of medicinal herbs suffered a strong setback. It was reduced or abandoned in many places, while gathering of herbs in the wild increased instead to meet demand. At the same time dedicated people, like Chen Cunren to name just one, were doing important research on the cultivation and processing of Chinese medicinal herbs, as well as systematically recording them. Chen Cunren compiled the first large-scale modern Chinese materia medica, which was published in 1935. It introduced the classification of herbs according to modern systematic botany, classifying the plants into family, genus, species, and listed 4,300 entries. This volume was followed by many others, all of which laid the foundation for us to be able to communicate internationally about the identity of Chinese medicinal plants.

The oldest extant records of the cultivation of a medicinal plant dates back to the oldest written Chinese texts of all known to date, the oracle bones.

Jumping to the 21st century, the “Outline on Modernisation and Development of Chinese Medicinal Herbs” for the period 2015-2020 stressed that herbal resources, their environment, biodiversity and the balance of biospheres should be protected and that recovery of critically reduced species must be taken care of in order to avoid their extinction. It is the first one to also include a national plan for the protection and development of Chinese herbal medicines aimed at guaranteeing sustainable use of resources as well as the sustainable development of the Chinese medicinal herb manufacturing industry.⁵⁶ This Outline makes it very clear that the measures mentioned are urgently needed. Many Chinese scientists are currently working to analyse these problems and bring them to attention, and they are calling for action. I want to end this section by quoting the suggestions made by two of them:⁵⁷

‘Respect the Daodi-habitat of medicinal herbs, do guided planning [of gathering, fostering as well as cultivation]; reasonably plan regional production areas; do more research on recovery of resources and sustainable use of endangered medicinal herb species; work on understanding the biology and reproductive needs of wild growing herbs to be able to cultivate them and so reduce the pressure on their natural resources and avoid their extinction; promote the development of seed banks for medicinal herbs; research to improve selection; industrialise production of seedlings; promote ecological cultivation of medicinal herbs, reasonable crop rotation and interplanting, as well as techniques such as covering of the crops with ground sheets [to keep moisture and suppress weeds without chemicals] etc., the preservation of biodiversity between fields to keep diseases and weeds at bay, and strengthening the soil; research the special needs of individual medicinal herbs; develop balanced fertilising.’⁵⁸

Some final comments

I have written this article as an update on the situation of Chinese medicinal herb production, especially regarding its sustainability. The developments I described in 2013 have become more accentuated and substantial changes are taking place. I hope I have been able to make these developments more transparent to readers. Of course, there is much more happening than I know of, let alone can describe here. Many more wonderful projects with their successes, as well as many failures happening for all kinds of reasons could have been described, but unfortunately exceed the scope of this article.

My own knowledge and understanding comes from having travelled to Chinese herb production areas every year for the past 15 years, discussing these issues with Chinese as well as European professionals in the field of medicinal herb production (cultivation, fostering and gathering), processing, scientific research in all of the fields mentioned above, export (from mainland China), import (into Taiwan and Europe) as well as reading articles on the above issues, some of which can be found in my references. Of course, however, what I have seen and heard remains limited.

There is no easy answer to the problem of sustainability of Chinese medicinal herb production. Good quality herbs from ecologically sound production at a low price will be less and less available the more the world becomes equally developed. We might lose some medicinal herbs before their price gets high enough for someone to start cultivating them.

As a consequence of all the difficulties and uncertainties in obtaining good quality Chinese medicinal herbs, some herbalists argue against using them altogether. Instead they suggest exclusively using European medicinal herbs, whereby a lot of the quality and safety concerns could be bypassed and our knowledge and understanding of these herbs could be expanded. I respect this point of view and

agree that for European medicinal herbs it is easier to back-track the origin of the herbs on sale and so to make an informed choice about where to buy them. It is also easier to grow one's own.

Precisely because I care about the circumstances of production of the medicinal herbs I use in my clinical practice as a TCM practitioner and because information from pharmacists and importers was scarce when I started practising, I felt I had to work on finding out more about this back in China.

The basic problem of aligning economic sustainability with ecological and social sustainability remains the same here and in China. The general level of education among producers of agricultural products like medicinal herbs is higher here in Europe and the pressure on natural resources of herbs is lower. The latter is so because, among other factors,⁵⁸ even our European medicinal herbs are often not produced in Europe, especially not in Western Europe, but in Eastern Europe or in even further away places like South America or ... China!⁵⁹ Nevertheless, feeling familiar with the herbs, we might be more aware of the need for transparency in the herbal supply chains - and more willing to pay a higher price for herbs we feel sure about.

When working with medicinal herbs from China, we might be more likely to ignore the fact that we have a role

to play as well. We can feel free from responsibility of the economical and social sides of production, only worrying about the ecological side. I am trying to show that these three are intertwined. If we are to continue working with Chinese medicinal herbs, I think it is important to be as well informed and as much involved involved as possible.

Nina Zhao-Seiler was born in 1965. She obtained her early TCM education (six years) in Zurich, San Francisco and Hamburg, followed by three years of internship and continuing education at the TCM University Teaching Hospital and private clinics in Chengdu, China. She has been running her own TCM practice in Zurich, Switzerland, since 1998 with a focus on paediatrics. Since 2002 she has led regular TCM herb study trips to China, taking participants to identify herbs in the wild and visit herb cultivation areas and processing facilities. Nina has a BA in Chinese studies and history from the University of Zurich and has taken the newly established Swiss national exam for naturopaths with a specialisation in TCM. She has initiated the first Chinese medicinal herb garden in Switzerland, which was opened this summer: www.tcm-garten.ch (German only). She is also a practitioner and teacher of Chen style Taijiquan. Contact: www.tcmherbs.org or www.tongtangpraxis.org

References

- Ang, F. & Van Passel, S. (2012). "Beyond the Environmentalists' Paradox and the Debate on Weak versus Strong Sustainability". *BioScience*, 62, 3, 251-259 <http://bioscience.oxfordjournals.org/content/62/3/251.full>, retrieved 20.7.2016
- Bärlund, K. (2005). "Sustainable development - concept and action". *UNECE annual report 2004-2006*, http://www.unece.org/oes/nutshell/2004-2005/focus_sustainable_development.html, retrieved 20.7.2016
- Chen Boyuan (Nov. 2015). "TCM feels chill". *China.org.cn*, http://www.china.org.cn/business/2015-11/05/content_36988901.htm, retrieved 11.3.2016
- Chinese Pharmacopoeia Commission (2010, 2015). *Chinese Pharmacopoeia* (中国药典, Zhongguo Yao Dian), China Medical Science Press (中国医药科技出版社, Zhongguo Yi Yao Keji Chubanshe) <http://eng.sfda.gov.cn/WS03/CL0757/122060.html> Published every 5 years
- Guo Qiaosheng & Wang Changlin (2015). "Retrospect and Prospect of Medicinal Plants Cultivation in China". *China Journal of Chinese Materia Medica*, 40, 17
- Harich, J. & Bangerter, P. (2014). "The three pillars of Sustainability", <http://www.thwink.org/sustain/glossary/ThreePillarsOfSustainability.htm>, retrieved 20.7.2016
- Hart, M. (1998). "What are weak and strong sustainability". *Indicators of Sustainability Training Course Outline*, <http://www.sustainablemeasures.com/Training/Indicators/WeakStrg.html>, retrieved 20.7.2016
- Heuberger, H. & Zhao-Seiler, N. (2016). "Cultivation of Chinese medicinal herbs in China and Germany - examples for sustainability and reliable quality", talk given at: Colloque du Réseau Suisse d'Ethnobiologie - Symposium des Netzwerks Ethnobiologie Schweiz, Neuchâtel University
- Heuberger, H. & Bomme, U. (2008-2014). TCM Züchtung <http://arzneipflanzen.fnr.de/projekte/tcm-zuechtung/> retrieved 20.7.2016
- Ibisworld (Mar. 2016). "Chinese Medicinal Herb Growing in China: Market Research Report". *Ibisworld*, <http://www.ibisworld.com/industry/china/chinese-medicinal-herb-growing.html>, retrieved 11.3.2016
- Ibisworld (Feb. 2016). "Chinese Medicine Hospitals in China: Market Research Report". *Ibisworld*, <http://www.ibisworld.com/industry/china/traditional-chinese-medicine-hospitals.html>, retrieved 11.3.2016
- Ibisworld (Aug. 2015). "Traditional Chinese Medicine Manufacturing in China: Research Report". *Ibisworld*, <http://www.ibisworld.com/industry/china/traditional-chinese-medicine-manufacturing.html>, retrieved 10.3.2016
- Friesen, D. (Jan 2013). "Traditional Chinese Medicine: Blockbuster or False Fad?". *CKGSB Knowledge*, <http://knowledge.ckgsb.edu.cn/2013/01/08/china/traditional-chinese-medicine-business-blockbuster-or-false-fad/>, retrieved 25.4.2016-04-25
- Li Xiwen, Chen Yuning, Lai Yunfeng, Yang Qing, Hu Hao & Wang Yitao (2015). "Sustainable Utilization of Traditional Chinese Medicine Resources: Systematic Evaluation on Different Production Modes". *Evidence-Based Complementary and Alternative Medicine*, 2015, Article ID 218901 <http://dx.doi.org/10.1155/2015/218901>, retrieved 10.3.2016 and <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4452863/>, retrieved 10.3.2016
- Ma Xiaoying, Guo Juan, Tang Jinfu, Ma Xiaohui, Ma Ying, Dai Zhuobo, Guo Lanping & Huang Luqi (2015). "Status and Future of Natural Resource for Chinese Materia Medica". *China Journal of Chinese Materia Medica*, 40, 10, doi: 10.4268/cjcm20151008
- Magnier, M. (19 Jan. 2016). "China's Economic Growth in 2015 Is Slowest in 25 Years". *The Wall Street Journal*, <http://www.wsj.com/articles/china-economic-growth-slows-to-6-9-on-year-in-2015-1453169398>, retrieved 25.04.2016
- S.R. (Jan. 2016). "The worries about China's slowing growth". *The Economist*,

- <http://www.economist.com/blogs/economist-explains/2016/01/economist-explains-11>, retrieved 14.3.2016
- Schader, C., Grenz, J., Meier, M.S. & Stolze, M. (2014). "Scope and precision of sustainability assessment approaches to food systems". *Ecology and Society*, 19, 3, 42, <http://www.ecologyandsociety.org/vol19/iss3/art42/>, retrieved 20.7.2016
- Thibaud, A. (March 2014). "Traditional Chinese Medicine: A Profitable Worldwide Trend". *Learn Chinese Business*, <http://learnchinesebusiness.com/2014/03/06/traditional-chinese-medicine-a-profitable-worldwide-trend/>, retrieved 11.3.2016
- Waldmeir, P. (Nov. 2015). "China looks to traditional medicine as tonic to boost growth". *Financial Times*, <https://next.ft.com/content/5b1969f0-7bce-11e5-a1fe-567b37f80b64>, retrieved 10.3.2016
- Wang Wen (Oct. 2015). "TCM products find their niche overseas". *China Daily USA*, http://usa.chinadaily.com.cn/epaper/2015-10/20/content_22234457.htm, retrieved 11.3.2016
- Xiao Peigen, Zhao Runhuai, Long Xingchao & Guo Baolin (2009). "Macroscopic analysis on production and marketing of medicinal material resources for sustainable development". *China Journal of Chinese Materia Medica*, 34, 17
- Yang Guang, Guo Lanping, Wang Nuo, Zeng Yan & Huang Luqi (2014). 'Study on supply and demand relation based on two stages division of market of Chinese materia medica'. *China Journal of Chinese Materia Medica*, 39, 2, 328-333 http://www.cjcmm.com.cn/cjcmmen/ch/reader/view_abstract.aspx?file_no=20140233&flag=1 retrieved 10.3.2016
- Yang Lulu, Chen Jianjun, Yang Tianshun, Li Zhong, Hu Weiming & Wang Ying (May 2013). "Geographic Distribution and Resource Survey of the Wild Medicinal Plants Licorice (*Glycyrrhiza uralensis*) in Northwest China". *Chinese Wild Plant Resources*, <http://210.45.134.251/KCMS/detail/detail.aspx?filename=ZYSZ201305012&dbcode=CJFQ&dbname=CJFDTEMP>, retrieved 17.7.2016
- Zhang Chunhong, Man Da, Wu Guodong, Li Zhenhua, Zhao Dongdong, Liu Yong & Li Minhui (2015). "Protection, exploitation and utilization states of specialized Mongolian folk medicine resources and related development strategy". *China Journal of Chinese Materia Medica*, 40, 5, doi: 10.4268/cjcmm201505
- Zhao-Seiler, N. (2013). "Sustainability of Chinese medicinal herbs: a discussion". *Journal of Chinese Medicine*, 101, 52-56
- Other references:**
Personal discussions during my annual travels to herb cultivation areas in China as mentioned in the text.

Endnotes

- Zhao-Seiler, N. (2013).
- The reason why this number is so high is that, in addition to some very commonly used herbs - e.g. Lian Qiao (*Forsythiae Fructus*), Ji Xue Teng (*Spatholobi Caulis*), Yi Mu Cao (*Leonuri Herba*) and Hu Zhang (*Radix et Rhizoma Polygoni Cuspidati*) - almost all less commonly used herbs are gathered in the wild because their cultivation would not be profitable. In addition to that, some herbs that can be and are cultivated are still gathered in the wild as well, e.g. Chai Hu (*Bupleuri Radix*) and Gan Cao (*Glycyrrhizae Radix*). In terms of harvested weight, herbs gathered in the wild only account for around 40 per cent of the annual harvest.
- These amount to around 60 per cent of the total market volume by weight and now include around 100 of the most commonly used medicinal herbs (Li Xiwen et al. [2015], Ma Xiaoying et al. [2015]).
- Information provided by Phytax laboratory in Switzerland, which tests TCM herbs for several importers in Europe. These substances include pesticides, herbicides and fungicides.
- However, just as in laboratory testing in other fields, the testing methods become increasingly able to show smaller and smaller amounts of substances at levels previously below detection. It remains to be seen which of these substances are actually relevant for health or disease in the detected amounts.
- Ma Xiaoying et al. (2015). My translation from Chinese, my additions in brackets.
- S.R. (2016), Magnier, M. (2016). Of course five to six per cent still seems a lot from our European perspective; for China it is the slowest annual growth in 25 years.
- S.R. (2016)
- Ibisworld (2015) on TCM manufacturing. Also Waldmeir, P. (2015) and Yang Guang et al. (2014).
- Numbers vary for recent years, but Ibisworld as well as Guo Qiaosheng & Wang Changlin (2015) estimate a total market value of Chinese medicines in China alone of around 100 billion USD in 2014.
- Thibaud, A. (2014)
- Heuberger, H., Zhao-Seiler, N. (2016)
- Li Xiwen et al. (2015)
- Even though international demand of Chinese herbal medicinals has grown at a yet even faster pace than demand inside China. See: Friesen, D. (2014)
- Dried and sliced paozhi-ed herbs ready for decoction.
- Over 3,600 Chinese medicine drug companies were registered in China in 2013, of which almost 25 per cent had only registered one patent medicine. Yang Guang et al. (2014)
- Yang Guang et al. (2014)
- GMP is an international quality standard for processing facilities. According to Yi Fei from Neautus Company, which was the first to receive GMP registration as a herb processing company in China (2003), the threshold to registration has become so high that many companies have not been able to renew their registration.
- In particular, root herbs used to be put in storage in good years, to avoid a break down of the price. Now, due to herb shortages as well as quality concerns (e.g. active ingredients reduced over time, pollution during storage from other substances stored nearby) reserves have decreased. I have seen several such huge store houses for herbs gathered in the wild as well as from cultivation.
- Li Xiwen et al. (2015)
- Including ecologic, economic and social considerations, which is the definition of sustainability in its broad sense, see aside box.
- Especially as GAP standard is designed for larger agricultural enterprises, so its requirements, for example concerning water quality control, can only be met by smaller producers if they join together to form a community.
- For example Jie Geng, which is much more lucrative when it is sold as fresh vegetable on the food market than when it is sold as a medicinal to pharmacies.
- Xiao Peigen et al. (2009), Li Xiwen et al. (2015) estimate that 20 per cent of all commonly used medicinal herbs are threatened.
- Li, Xiwen et al. (2015)
- Xiao Peigen et al. (2009)
- Personal discussion at the College of Medicine, Baotou, Inner Mongolia and with medicinal herb wholesalers in 2014.
- Li Xiwen et al. (2015)
- These are some of my personal thoughts on the issue. There is much thought and effort being devoted to the question of how to regulate wild gathering in a sustainable way and a number of projects are already being realised, see below.
- Li, Xiwen et al. (2015)
- Xiao Peigen et al (2009), Li Xiwen et al. (2015) and personal conversation with Dr Chen Chu of the Sichuan Academy of Chinese Materia Medica.
- Pharmacopoeia of the People's Republic of China* (2015)
- Personal conversation with Prof. Li Longyun of Chongqing Academy of Chinese Materia Medica.
- Specific regions considered especially suitable to the growth of individual herbs. One

- defining feature is that these herbs must have recorded as being gathered or cultivated in that region for several hundred years. Herbs having grown in their Daodi region are so called Daodi Herbs and are considered high quality.
- 35 In Li Xiwen et al. (2015)
- 36 One way out of this situation is contract farming, which means farmers cultivate what has been pre-ordered by the buyer, to set conditions defined in a contract. This gives both producer and buyer (and in the end the consumer, due to easier traceability) more security with less flexibility. Many large herb processing companies in China work with contract farming for a large part of their needs. Contract-farming is also the basis of most fairtrade-systems. In Germany, in the last 20-30 years, this concept has enabled local herb producers to reach financial sustainability and even some growth.
- 37 Although I have seen spectacular exceptions to this overall tendency: in Sichuan there are Daodi regions for Dan Shen (*Salviae miltiorrhizae Radix*), Chuan Xiong (*Chuanxiong Rhizoma*), Jiang Huang (*Curcuma Longae Rhizoma*), Yu Jin (*Curcuma Radix*) and E Zhu (*Curcuma Rhizoma*) where these herbs have been grown in the same fields for at least 300 years without any major disease, just thanks to favourable soil and climate conditions, soil flushing and good clones.
- 38 In Li Xiwen et al. (2015)
- 39 As a side note: one of the differences between European and Chinese organic standards is that, although both focus on regulating procedures and both require an initial test of the nutritional status of the soil, in China the initial level of potentially harmful substances in water, air and soil must also be tested.
- 40 Li Xiwen et al. (2015)
- 41 This is the name of the species, not the pharmaceutical name. To my knowledge no pharmaceutical name has been defined for this herb.
- 42 As above.
- 43 See aside box.
- 44 Zhang Chunhong et al. (2015)
- 45 Li Xiwen et al. (2015). Many natural fostering projects have been realized in the past few years, among them one for both Gan Cao and Fang Feng, reaching 4,000 square hectometres near Hangjinqi, Inner Mongolia.
- 46 http://www.unece.org/oes/nutshell/2004-2005/focus_sustainable_development.html
- 47 <https://en.wikipedia.org/wiki/Sustainability>
- 48 Ang, F. et al. (2012), Hart, M. (1998)
- 49 The populations of many decimated medicinal herb plants actually recover within three to five years, if they get a chance before they are too low in numbers. This observation, made in 2014 during The Third National Census of Chinese Medicinal Herb Resources, has also been communicated to me in a personal discussion with Dr. Chen Chu. Also in Li Xiwen et al. (2015).
- 50 Zhang Chunhong et al. (2015)
- 51 For example in the question of drying procedures: how do the constituents change if the root is dried with a fermentation process yielding a darkened root (traditional for some herbs) compared to roots that are freeze-dried?
- 52 Herbal material from a Daodi area.
- 53 As a guideline for responsible industrial scale production.
- 54 For a description of their work see Heuberger, H. & Bomme, U. (2008-2014).
- 55 Guo Qiaosheng & Wang Changlin (2015)
- 56 Guo Qiaosheng & Wang Changlin (2015)
- 57 Guo Qiaosheng & Wang Changlin (2015). The article - on the retrospect and prospect of Chinese Medicinal Herb Cultivation - explores these issues in great detail. My translation from Chinese.
- 58 One of which is that we have already long ago picked some of our herbs to extinction, for example *arnica montana*.
- 59 https://en.wikipedia.org/wiki/Arnica_montana, retrieved 4.4.2016
- https://de.wikipedia.org/wiki/Maca_%28Pflanze%29, retrieved 4.4. 2016
- https://de.wikipedia.org/wiki/Echte_Kamille, retrieved 4.4. 2016