



Value chains of herbal medicines—Research needs and key challenges in the context of ethnopharmacology

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ABSTRACT

Background: Value chain analyses are commonly used to understand socioeconomic and power relationships in the production chain from the initial starting material to a final (generally high value) product. These analyses help in terms of understanding economic processes but also have been used in the context of socioeconomic and socioecological research.

Aims of the study: However, there is a gap in the ethnopharmacological literature in terms of understanding what relevance a critical analysis of value chains of herbal medicines could have. Here we provide a research framework for achieving such an analysis.

Methods: An extensive review of the literature available on value chains and their analysis was conducted, based both on a systematic online search of the relevant literature and a hand search of bibliographies and discussions with experts in value chain analysis

Results: While the concept of value chains is commonly used in the relevant industries, very few studies investigate the value chains of herbal medicines and products derived from them. The studies identified mostly look at socio-ecological aspects, especially in the context of sustainable resource use. We suggest an analytical framework which can help in understanding value chains in the context of ethnopharmacology and can serve as a basis for addressing questions related to value chains and their relevance in ethnopharmacology.

Conclusions: We identified a crucial gap in current ethnopharmacological and medicinal plant research which impacts on a wide-range of factors relevant for a sustainable, socio-culturally equitable and safe supply of herbal medicines.

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1. The concept of value chains

In this commentary we discuss the concept of value chains specifically as it relates to their role in the creation of products and value from local ethnopharmacological resources and its relevance for research on medicinal and health food plants.

In a broad sense a *value chain describes the sequence of activities required to make a finished product from its initial starting material* (e.g. from field crop or gathered wild material) (Chopra and Meindl, 2004). Value chain research focuses on the nature of the relationships among the various participants involved in the chain, and on

their implications for development. In practical terms, value chains are descriptions of the transactions and processing of a product until it reaches its end market, and will include various kinds of processing, transportation and branding.

However, while this sounds like a neutral, technical process, a key element of the value chain literature has been the recognition that the various actors in the chain are likely to have greater or lesser degrees of power, reflected in the kinds of incomes that each earns but also in the characteristics of the final product (Giuliani et al., 2005; Kaplinsky, 2000). The impetus for value chain work arose from the increasingly varied value chains that can be seen for many products, both in terms of the addition of value (e.g. from simple, undifferentiated agricultural commodities to highly-processed, branded products) and the geographic distances that they cover (e.g. from very localised markets to international ones). A fundamental distinction in the value-chain literature is between producer-driven chains and buyer-driven chains (Gereffi, 1994). This reflects the changing dynamics of the international trading system. For many commodities, changes in the regulation of

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international markets have increased competition among growers and traders, while, at the same time, it has become clear for certain value chains, final markets have been dominated by certain supermarkets or certain brands.

The focus of value chain research has been two-fold. One focus has been to understand how different kinds of value chain confer competitive advantage, by changing the way that a product is processed or sold (Recklies, 2001). Aside from this, value chain analysis has been used as a tool for understanding socioeconomic benefits, disadvantages and risks for the various member of such a chain. This second approach has been used successfully, for example for understanding the benefits of gathering non-timber forest-products most notably of plant and animal derived commodities with a high value (e.g. Wynberg et al., 2003), in the discussions about the benefits of Fairtrade products (e.g. Stiglitz and Myers, 2006), and generally for assessing the relative benefits of high value, medium volume agro-forestry products like tea, coffee, and chocolate (e.g. Blowfield, 2004).

A key element of these debates has been an assessment of the relative benefits to the primary producers, as compared to middlemen, wholesalers and retailers. Often it was found that farmers or gatherers only obtained a minimal share in the benefits of such products (e.g. Litvinoff and Madeley, 2007).

Medicinal herbs, and the products derived from them, also seem to have very varied value chains. However, despite the size of trade in medicinal herbs and herbal products, surprisingly, very few studies have looked at the value chain. The WHO has estimated the demand for medicinal plants is approximately \$14 billion per annum (2006) and the demand is growing at the rate of 15–25% annually. The WHO estimates that by 2050 the trade will be up to US\$ 5 trillion. We argue that the global value chain approach is a valuable analytical tool in understanding the impact of these changing patterns of internal trade in medicinal herbs and herbal products. This is despite the general criticisms that have been made of the global value chain (GVC) approach (Bernstein and Campling, 2006; Gilbert, 2008; Selwyn, 2007). Criticisms have focused on the inability of a GVC analysis to explain consumption patterns and for the inability to understand the general conditions of employment and production in poor countries. As such, a GVC approach allows us only to look at a particular slice of economic production. Despite this, the value chain approach can help us understand the kinds of impacts associated with the production of medicinal herbal products.

By understanding the external and internal linkages within production, processing and trade networks, it is possible to understand more clearly why the quality of herbal medicines may vary in different markets. The concept of the value chain also helps us understand the socio-economic impact of this growing international trade, by illuminating the very different returns received by actors within different value chains. This commentary sets out some basic research needs in this area and offers a general model for assessing global value chains in herbal medicine.

2. Value chains of medicinal plants – evidence so far

While general reference to the topic of value chains is made in some articles (e.g. Stewart, 2003; Winkler, 2008) and while there is a relative abundance of reports on a range of food products (incl., tea, coffee; e.g. Menon, 2008; Wynberg et al., 2003; Bryceson, 2008), only a limited number of studies on value chains of herbal medicines exist. Two examples of research on regional value chains from South America with a strong ethnographical focus include Busmann and Sharon (2009) and Revene et al. (2008). Alam and Belt (2009) looked at the ecological threats to resources

with respect to medicinal plant species and their depletion at a rapid pace due to over-collection from their natural habitats. The collection and marketing of medicinal plants from the wild is an important source of livelihood for many of the poor in developing countries. For example in Nepal, more than three hundred thousand households are engaged in the collection of medicinal plants. A key outcome of their research has been the call for tightening restrictions on collection practices and secondly through advocating cultivation on a large scale.

Alam and Belt (2009) work focused on a project in Uttarakhand, northern India. It was proposed that the cultivation of a medicinal plant, Kutki (*Picrorhiza kurroa* Royle ex Benth.), Plantaginaceae, would benefit the farmers financially, provide social benefits and help preserve wild species. The European buyer would also benefit from having a secure supply of the plant from a fully traceable source. Although the authors claim that this was the first initiative of this kind between Indian farmers and a European company, there have been similar partnerships established in the UK for some time (Interview with Sebastian Pole, Pukka Herbs, 2011). The Uttarakhand project produced disappointing results and in their paper the authors highlighted the reasons for this as being poor quality of planting material, planting on small, poorly irrigated plots, and the emergence of apples as a profitable cash crop, resulting in farmers switching from kutki to apples.

Alam and Belt (2009) conclude that the cultivation of medicinal plants is more difficult than usually suggested in the scientific literature and government promotional material and stress the importance of agencies and NGOs taking these difficulties into account and take steps to minimise these difficulties. The authors further argue that, a thorough technical and economic feasibility study of the value chain, long term involvement and an understanding of the prevalent farming systems are required to ensure the success of the chain.

A more optimistic outlook with respect to the economic potential of medicinal plants in Bangladesh is provided by Shahidulla and Haque (2010) who suggest that a vertical integration is needed in order to benefit producers and processors at the beginning of the value chain. Their findings indicated that the primary and wholesale secondary markets were dominated by middlemen and their study challenged the view that medicinal plant cultivation was only appropriate for relatively well-off people with better access to land, capital and information. The authors argue that some of the mechanisms employed in developing and sustaining institutional relationships may also apply equally well to defining the medicinal plant value chain and list contracts, quasi-vertical integration (especially close and long term relationship), tapered vertical integration (when a company sources inputs externally from independent suppliers as well as internally within the same company), cost plus agreement (the contractor is paid a negotiated amount regardless of incurred expenses), joint ventures and strategic alliances as examples of these potential relationships. Moreover, they argue that the benefits of an integrated value chain are numerous. It enables primary producers to become active participants in the process, it removes market access barriers, results in better commercialisation of products and is attractive to companies as they can have greater control over quality and supply.

Contrary to previous views of Alam and Belt (2009), Shahidulla and Haque (2010) found that the cultivation or production of medicinal plants could play an important role in improving the livelihoods of poor or extremely poor people owning meagre strips of land. They argue that in order to sustain growth in medicinal plant production, a fair distribution of the gross margin to the primary producers is necessary. In the value chain system examined, it was found that downstream buyers, especially manufacturers and consumers pay most of their money for middlemen's value

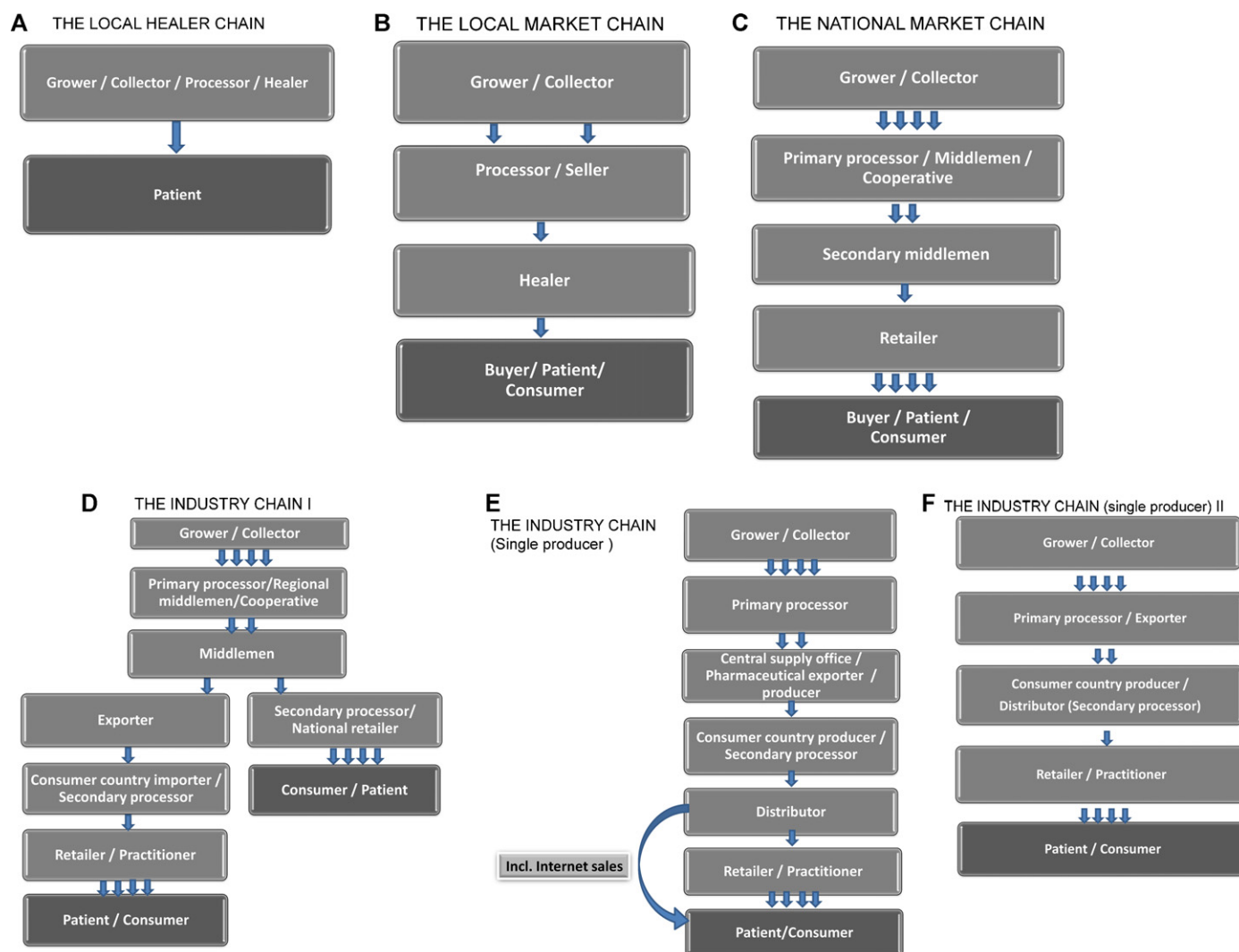


Fig. 1. The different types of value chain found in the context of the herbal medicines and herbal medical products trade.

additive opportunistic pricing due to inherent weaknesses in the chain. It is suggested that a vertically integrated chain, with only producers and processors as commercial actors and NGO's as promoters as shown in Fig. 1e and f (see the discussion below) could create an economically robust system which will benefit the many rather than the few.

One functional food or nutraceutical that seems to be working well for some groups of producers is green tea, a product mostly consumed as a health beverage, but which also has been associated with specific therapeutic benefits. Presumably because of the high demand for this relatively highly valued product and because of well established supply chains, many producers offer high-quality green tea products. It is widely reported that tea cultivation in the countries where it is prevalent has historically demonstrated a positive impact on the economy of the poorer rural areas (e.g. Ahmed et al., 2010; Fairtrade, 2010; Overview, 2006; Carnegie Council for Ethics in International Affairs, 2011). Tea cultivation often requires companies to provide employment to large numbers of the least privileged segments of society, mostly in remote areas where there is little other infrastructure. As a result, roads, electricity, water, etc., become more widely available to the general populace in these isolated districts. In India for instance, the major tea plantation companies provide affordable housing, medical care and education

to their employees and their employees' families. Wage agreements are usually industry-wide and salaries are above the national average (Menon, 2008).

Green tea production is chiefly located in South-East Asia and particularly in China, which is responsible for 75% of all green tea produced (Overview, 2006). Although much of the Chinese tea production is conducted on small farms rather than large tea plantations, according to Liu (2010), Unilever has invested tens of millions of Yuan in establishing a research centre on tea and traditional Chinese medicine in Anhui province. The plant has a production capacity of more than US\$ 15 million per annum.

Although this seems to be a win-win situation for rural workers, as outlined below, there is a counter argument: the companies are the major winners through their exploitation of the farmers and their workers, who in turn have few alternatives other than to subjugate themselves either to the multi-national or state run companies (Morser, 2010) (see also below with respect to the Fairtrade movement). They find themselves increasingly dependent on a wide range of exterior inputs ranging from seed to fertilisers to pesticides (Vasquez, 2011). The relative bargaining power of producers at the cultivation end of the value chain generally seems to be relatively weak compared to the processors and retailers who are able to exert control on both the price paid for the raw crops and

the essential inputs needed to produce economically viable yields (Lines, 2006).

The future for the growth of green tea production is inextricably linked to its health claims, but it is not only the health of consumers in Europe that are affected, but also the workers and farmers in the countries of origin. In Vietnam, tea producers often benefit from better living standards than producers of other crops with reports of incomes doubling through tea production (Agrifood, 2004). However one key report suggests that the overuse of pesticides by producers leads to pesticide residue rates that far exceed international limits exposing tea pickers to high levels of toxins that are hazardous to health (SNV, 2010).

One initiative that seems to be having a beneficial effect on both the incomes of farmers and the quality of produce is the Fairtrade scheme, which mostly covers agricultural food products. This has been particularly noticeable in the tea and coffee markets and the broad based aim of the Fairtrade movement is to offer a better deal for farmers by paying above the market rate for the commodity in question and in return the farmers are expected to adhere to the Fairtrade policies on production and follow quality-driven requirements in key areas, particularly in the cultivation and collection stages. Although basically, this is to be welcomed the scheme is far from a panacea as it only represents a small section of the total market and may be more suitable in some countries than others (Farnworth and Goodman, 2008).

Fairtrade schemes also tend to favour larger companies and, despite of all attempts, have had little influence on the wages of the poorest workers or farmers. In other words, Fairtrade seems to favour the larger farms. One of the major reasons that the price of tea can be kept so low is due to the domination of the tea sector by a few companies and it is seen in the breakdown of who accrues the largest share of the value chain that the highest earners are the traders and retailers. According to the Fairtrade statistics (2010) in the normal trade approximately 40% of the retail price of tea accrues to the tea traders and manufacturers, and a further 40% goes to the processors/blenders, packagers and retailers, based mainly in rich countries. In tea-producing countries, around 15% of the retail price goes to the plantation and factory, and less than 1% to the auction broker. The plantation worker is likely to earn 1% or less of the retail value. One central question is how can the green tea industry be sustainably developed to optimise the health benefits at both ends of the supply chain? Workers and small farmers have historically been weakened and marginalised and today hold a relatively minor position in the tea value chain. A downward pressure on the price paid for tea to the farmers and subsequently on the daily wages of the workers, causes poverty and distress among hundreds of thousands of people whose living depends entirely on tea production. At the same time traders and tea packers are continuing to realise large profits (Oxfam, 2002). It is claimed that large companies have a policy of deliberately reducing differences in quality among the different teas produced all over the world enabling teas to be purchased at the lowest cost and maximising profits from the blending, packaging and marketing stages which tend to be in the hands of the large tea oligopolies (Oldenziel and Otten, 2006). There are certainly parallels to be drawn between tea and the medicinal plant value chain and the industry should be cautious of engendering an industry that follows blindly in the footsteps of the tea trade. Schemes such as Fairtrade, although not perfect, have shown that it is possible to develop a better working relationship with farmers and that profits can be distributed more fairly along the value chain. This fairer trading approach can have benefits to all actors along the chain. The rewards for the farmers and producers at the beginning of the chain are often the focus but there are also benefits for the retailers in terms of reaching a different target market and one that is often prepared to pay a premium price for more ethical trading.

Based on our systematic review of the literature there seems to be no systematic evaluation whether different value chains have an impact on the quality and on the health benefits of green tea products. Thus, overall and with the exception of a product like green tea, there are very limited studies using the value chain concept and it is mostly linked to research and policy implementation needs in the context of sustainability and local livelihoods. The example of green tea, on the other hand demonstrates the way in which a value chain approach can illuminate a wider range of important factors.

3. Value chains of medicinal plants – conceptual models

Since no systematic assessment of value chains of medicinal plants exists, we systematically compared various routes how products reach a market (see Fig. 1). Based on the recent developments in the global markets of medicinal plants (Kala et al., 2006), value chains that originate in some Asian countries and especially in India and China are of particular interest.

In its most simple form, an ethnopharmacological value chain may simply link a healer with his or her patient (Fig. 1a). This is, of course, what is found in many classical ethnopharmacological studies which involve the investigation of local and traditional knowledge. In essence the healer is the prescriber and supplier of a plant to be used as a medicine (or he advises the patient on what to collect and use). If such a medicine is supplied it may be grown or collected by the healer and – especially in certain systems – the herbal material may be subject to often complex processing. Generally a healer has detailed knowledge about these plants and will be able to identify it properly as well as ascertaining that it is of a culturally acceptable composition and quality.

Very often such healers are now relying on some sort of small scale local trade to secure the material they are prescribing or processing (Fig. 1b). Clearly this has an impact on the quality of a product, how this quality is monitored, and how value is generated from it. It also may have important implications on the sustainability of use and impact on a species' availability as a commodity. Obviously, this also impacts on the value of the product and the economic benefits made from it or its cost to the patient, respectively.

These two differ from all other examples in Fig. 1, by in essence relying exclusively on *small local networks and on one to one relationships between the partners*. As shown in Fig. 1c and d, more complex value chains generally involve middlemen who are likely to procure material from a wider range of primary producers (farmers or gatherers). In this case the middlemen in essence serve as a bridge between the primary producer and the retailer or end user. Of course, there may well be various levels of middlemen, which build up a supply chain for a specific product or more commonly a range of products. Such middlemen often also serve as money lenders or as suppliers of industrial goods which are sold in the local communities. The key difference between the two figures (Fig. 1c and d) is that one is essentially a national chain, while the other one integrates the consumers into the international or global markets structures. It also highlights that, if this is the case, there will be a national and an international supply chain. As before the differences between these two groups may often be blurred, and are likely to change over time. This value chain has a certain similarity to the ones for high value, medium volume products like tea or coffee.

The final two possibilities highlight and increased industrialisation of the process. In one case (Fig. 1e) several companies are involved throughout the supply chain (tapered vertical integration). Alternatively, it may be that the whole process is largely in

Table 1
Probability that the retailer or practitioner at the end of the value chain has control over the given inputs in the various parts of the value chains as outlined in Fig. 1. This control includes the products value, but as importantly its quality (and thus safety). With an increasing reliance on more and more complex value chains there will have to be new measures that need to be implemented in order to ascertain such a control.

	A	B	C	D	E	F
Local control of quality parameters	*****	***	**	*	*	*
GACP (Good agricultural and collection practice)	n.a.	n.a.	**	***	****	****
Traceability	****	**	*	***	****	****
Pesticide usage	****	**	**	***	***	****
Storage conditions	****	***	***	***	***	****
Distribution	***	***	***	***	***	****
GMP (Good Manufacturing practice)	n.a.	*	*	***	***	****
Process control	*****	***	***	***	****	****
Analytical testing	n.a.	*	*	**	****	****
Documentation	**	**	**	***	***	****
Pharmacovigilance	n.a.	n.a.	*	*	**	**

n.a.; Not applicable.

* Very unlikely.

** Unlikely.

*** Probable.

**** Very probable.

***** Highly probable.

the hands of or controlled by one company, normally one well-placed at the end of the supply chain (Fig. 1f) (e.g. a pharmaceutical producer or a large retailer).

This simplified model suggests that individual producers who grow and use their own medicinal plants have a reasonable amount of control over quality inputs within the chain, this control is lost as more middlemen and steps are introduced and then recovered with some additional inputs as a vertically integrated chain is established.

Contrary to the examples of value chains in other sectors discussed above, value chains in the field of herbal medicines vary tremendously in their structure. Rather than a simple contrast of being a producer-driven or buyer-driven chain, there are likely to be a range of different relationships. This has implications on all levels, including the social and economic conditions, the welfare of those involved in production and processing, as well as trade flows between individuals, companies and nations, all aspects of quality assurance and in a very broad sense on the governance in the area of herbal medical products (see Table 1). This table highlights the level of control a user at the end of the value chain (e.g. a healer, a medical doctor or other practitioners or a retailer) has on parameters that impact on the quality and consequently, the safety of a product which goes through the value chains presented in Fig. 1a–f. While these are in essence theoretical postulations, they are based on the data retrieved in our search and on information received from stakeholders in the sector. The assessment in Table 1 should therefore serve as a starting point for systematic research into this. Good agricultural and collection practice (WHO, 2003), for example, is relevant for complex supply chains, and often is particularly well developed in industrial value chains like the ones shown in Fig. 1e and f. Clearly this also strongly impacts on cultural and ecological conditions for those who are the primary producers of these materials.

The EU's Traditional Herbal Medical Product Directive, for example, is, among other assumptions, based on the implicit recognition that the market for herbal medical products has been changing and has become reliant on much more complex and interrelated value chains. This concept of value chains and how they change in response to market forces can be demonstrated very well in looking at the recent developments in key producer and consumer countries of herbal medicines – India and China (e.g. Kala et al., 2006; Alam and Belt, 2009; Shahidulla and Haque, 2010; Ravishankar and Shukla, 2007; Vaidya and Devasagayam, 2007; Giuliani et al., 2005; Kaplinsky, 2000).

4. Examples of medicinal plant production in India and China

In India herbal medicines are produced by several thousand, mostly quite small companies, including numerous neighbourhood pharmacies that compound ingredients to make their own remedies (similar to our model 1c). Kala et al. (2006) assert that of the 17,000 higher plants to be found in India, 7500 are known for medicinal uses, with Ayurvedic medicine claiming to use 2000 of these, most of which are collected from the wild. More than 60 species are in great demand and the so-called tribal belt of India is abundant in these plants and these minorities (ethnic groups) mainly depend on this trade for their lively hoods. More complex value chains (like our models (E and F) are likely to be mostly of relevance for these sixty species. Adulteration and contamination is commonplace and so the supply of good quality raw materials is limited. This limitation on good quality raw materials has stunted the industry's growth in previous years.

More and more species are being gradually added to the *materia medica* and the standards for purity and identification do not always keep pace with this expansion process. It is estimated that the total value of products from the entire herbal production in India is in the order of US\$ 1 billion. The industry has been dominated by less than a dozen major companies for decades, joined recently by a few others that have followed their lead. Ayurvedic medicine production in India is dominated by three companies that produce about 85% of the Indian domestic market: Dabur, Baidyanath, and Zandu. The products of these companies are included within the broad category of “fast moving consumer goods” (FMCG) which mainly involves foods, beverages, toiletries, cigarettes, etc. Most of the larger herbal medicine suppliers provide materials other than herbal medicines, particularly in the areas of foods and toiletries (Dharmananda, 2003). According to Polshettiwar (2006) in India, there are about another 20 well-recognized manufactures of herbal drugs and 140 medium or small-scale manufactures. In addition, thousands of *vaidyas* (traditional healers) have their own miniature manufacturing facilities. About 1200 licensed small manufactures in India are on record. India contributes less than 1% to the global herbal market; however, it is fast emerging as a key supplier of medicinal plants across the globe. The Indian Traditional Herbal Medicines Act, 2006 regulates the sale of the traditional herbal medicines which are marketed without any licence and control on the basis of being from ancient texts. According to the act every retailer or seller of traditional herbal medicines needs to have

a licence to sell traditional herbal medicines from the competent authority (Mukherjee et al., 2007). A national organisation 'The Ayurvedic Drugs Manufacturers Association' is reportedly taking a pro-active role to improve quality and research but is in need of funding if it is to make any significant contribution.

However, while Ayurveda has traditionally been the province of home remedies (or short value chains), producers of such Ayurvedic and other herbal medical products are going increasingly 'high-tech' (Seale, 2011) and aim for wider commercialisation (e.g. Mukherjee et al., 2009). Also there is now a strong emphasis on expanding these markets. Exports of herbal products from India increased to from US\$ 69 million in 2005–06 to US\$ 128 million in 2009–10, recording a compounded annual growth rate of 16.8% (Scindia, 2010). USA, Pakistan, Germany, Japan, the UK, Spain, China, France, Vietnam, Mexico, were the top ten export destinations for India's herbal exports over the last three years. The United Kingdom remained the fifth largest overseas market for Indian herbal products with exports worth US\$ 3.7 million in 2007–08, and US\$ 5 million in 2008–09. The UK had a 2.5% share in the country's total herbal exports in 2009–10 (Scindia, 2010).

Taking these data together, it is apparent that India is fast developing a complex and mutually dependent national and export industry. Originating from many small and practitioner controlled value chains, the market is now dominated by some key industrial players.

The Department of Ayurveda, Yoga & Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) within the Ministry of Health & Family Welfare is focussing on its regulation and on the improvement of standards in the areas of quality control and standardisation of drugs, improving the availability of raw materials, research and development, education/training of professionals and wider outreach about these traditional medical systems.

Pharmacopoeia Committees have been established to develop quality standards for the main groups of therapeutically relevant drugs of Ayurveda, Unani, Siddha and Homoeopathy (Mukherjee et al., 2007).

The Indian Government also established an independent body – the "National Medicinal Plants Board" under the Ministry of Health and Family Welfare. It is responsible for co-ordinating all matters relating to the development of medicinal plants, including policies and strategies for conservation, proper harvesting, cost-effective cultivation and marketing of raw materials in order to protect, sustain and develop this sector. Uniquely, the Indian government has established programmes for the documentation of traditional Indian knowledge, which is already available in public domain. The political goal is to safeguard the sovereignty of this traditional knowledge and to protect them from being misused in patenting on non-patentable inventions. The Traditional Knowledge Digital Library (TKDL) is an original proprietary database, which is fully protected under national and international laws of Intellectual Property Rights and is maintained and developed by the government. TKDL also allows automatic conversion of information from Sanskrit into various languages. The information includes names of plants, Ayurvedic description of diseases under their modern names and therapeutic formulations (Mukherjee et al., 2007) (Fig. 2).

China has a longer history of cultivating and marketing medicinal plants compared with India. There are hundreds of companies producing traditional Chinese medicines, many of which export their products internationally. On the one hand, according to Patwardhan (2005) India should take the lead from China in developing a more quality driven ethos towards medicinal plant production. However, China has overcome its own difficulties by continuously and vigorously modernising its traditional medicines profession with government sponsored Good Agricultural Policies (GAP's) and Good Manufacturing Practices (GMP's).



Fig. 2. Location of main medicinal plant manufacturers in India (★).

The government has introduced a policy where all manufacturers of TCM products must comply with standards set down by the State Food and Drugs Administration (SFDA) in order to gain GMP certification. Only around 1500 companies have achieved this standard. Chinese attitudes to medicinal herb production are changing rapidly. There is some evidence to indicate that Chinese farmers and pickers are beginning to move away from the traditional route of selling their herbs at the local or provincial herb markets and are beginning to form alliances with local pharmaceutical companies or with regional sourcing companies in order to gain access to the more lucrative export market. Thus the value chains are changing (cf. Fig. 1). For the farmer the benefit to this approach is that the buyer can give targets for the farmer to aim for and agree a price at the time that will not be affected by many of the market shocks that impact the market traders. With the assistance of academic institutions and NGO's, local companies are able to provide advice and support to farmers on growing techniques including the correct use of fertilisers and pesticides. By paying an agreed price for an assured quantity of herbs the buyer can expect to have some input and control over the quality of the herb material; the sourcing company can ask for crops to be collected at certain times of the year and that they be collected, dried and stored in accordance with the buyer's specification. This seems to be a logical and pragmatic approach to satisfying both the demands of international trade and the need to assure consistent and stable price structures. However, one has to argue whether the regulatory processes are in fact keeping pace with these changing supply and value chains. Clearly, this approach is a long way from replacing traditional market systems as it is the very nature of an unstable and fluctuating market that continues to attract and sustain interest in the medicinal plant trade at the market level for many traders who use medicinal plants as a commodity resource.

Both nations have been impacted by the European Union's Traditional Herbal Medicines Directive, 2006 which regulates the sale of traditional herbal medicines which are marketed without any licence and control on the basis of being from ancient texts. According to the act every retailer or seller of traditional herbal

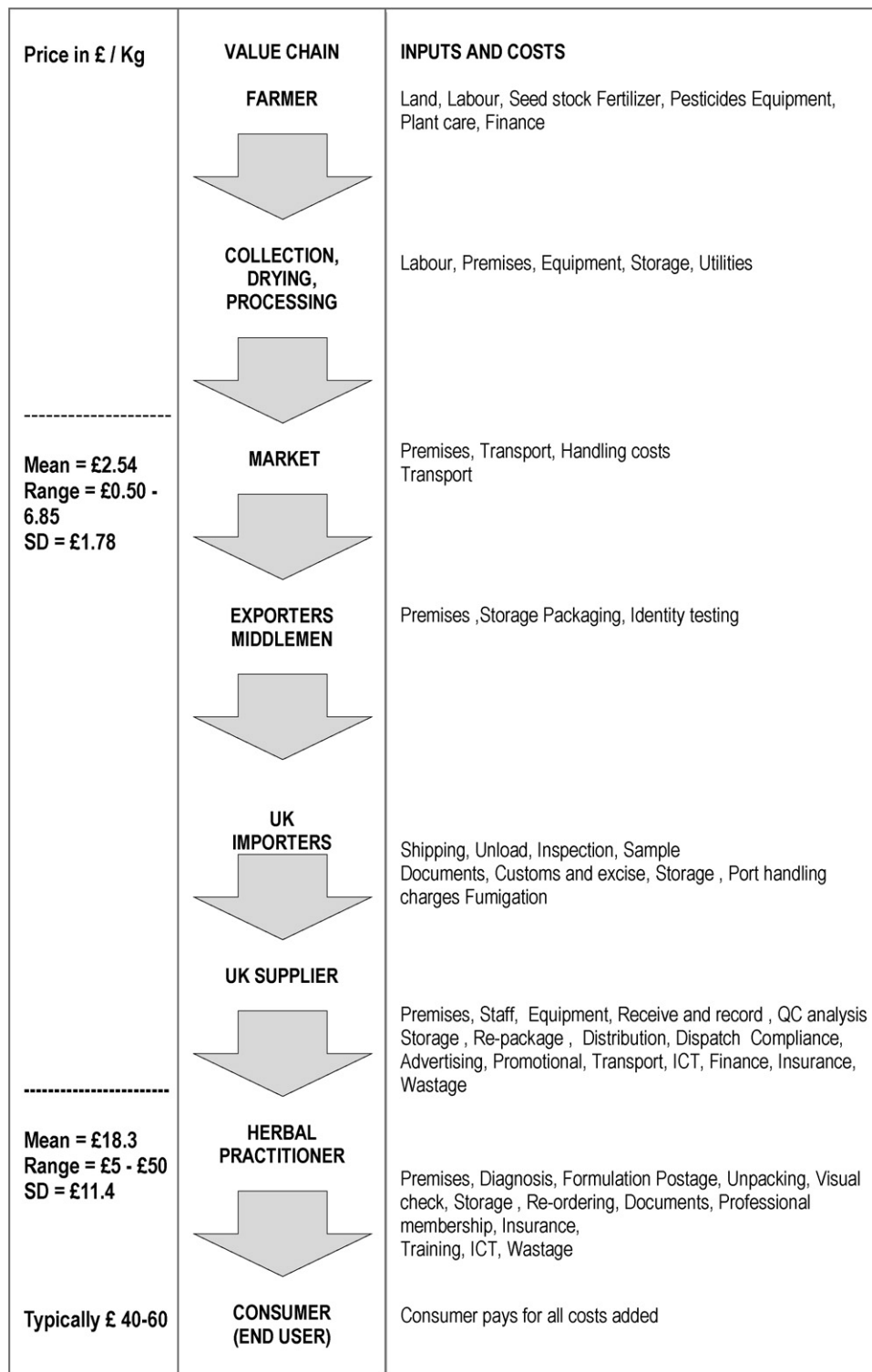
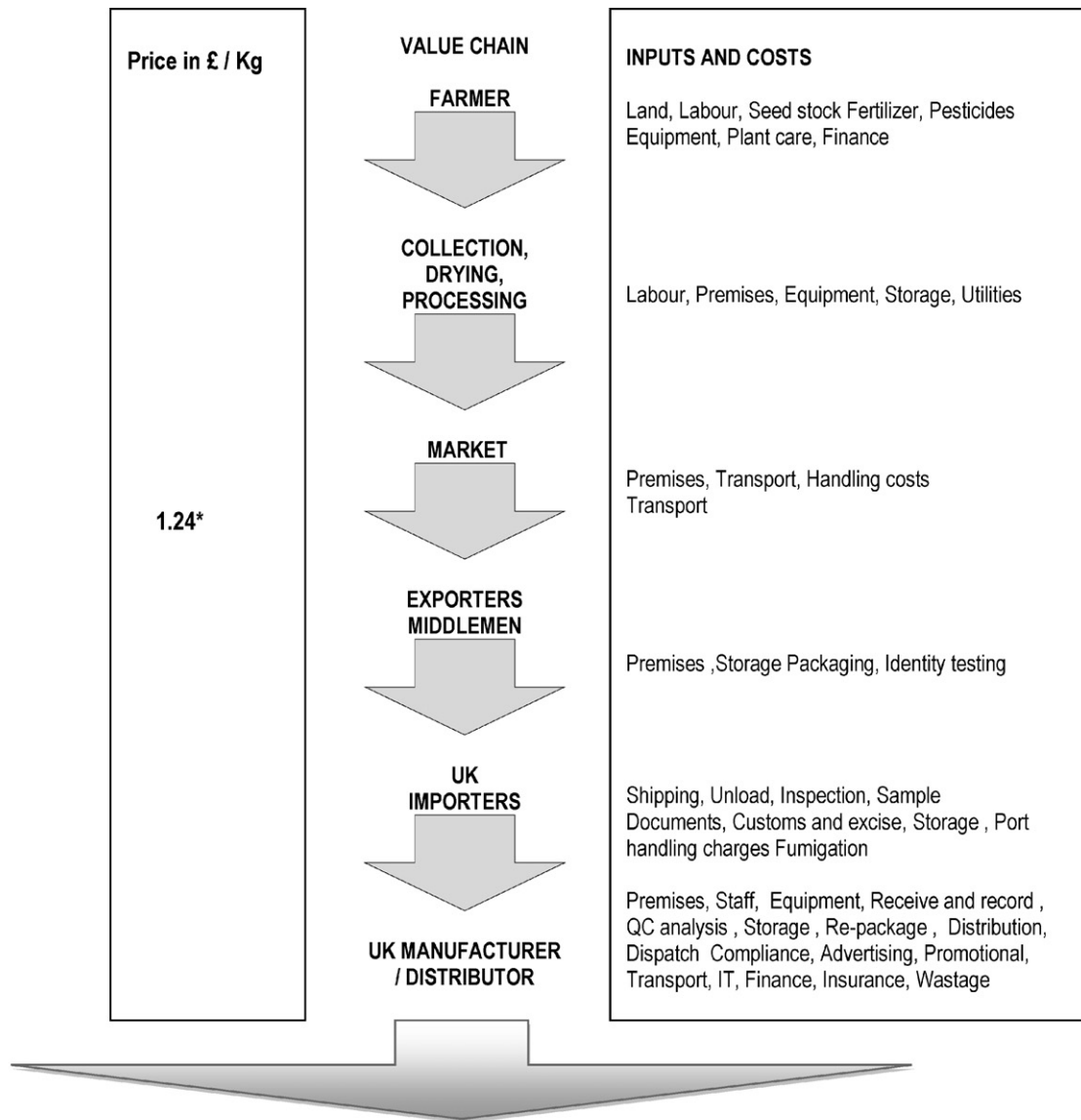


Fig. 3. The herbal practitioner value chain of crude botanical materials begins with the herb grower in Asia and finishes with the consumer in Europe. As the herb material moves along the chain, value is added in terms of costs and profits to the producer and it is the consumer who will eventually pay for these costs and value added. (Prices based on values for 20 randomly selected commonly used East Asian herbs with a local market price equivalent of £ 0.5–7.0. Survey locations – Bozhou TCM market PRC (April 2011), a UK TCM supplier and UK practitioner clinics (November 2011)).

medicines needs to have a licence to sell traditional herbal medicines from the Authority. Every manufacturer of traditional herbal medicine needs to work under the principles of GMP, having to list the ingredients of each medicine on the packaging of the medicine along with the exact quantity. Side effects and warnings of contraindications need to be stated on the package, adding complexity to the value chain.

Pharmaco-economic studies on TIM and TCM are rare but can help in understanding cost-effectiveness and cost benefit of traditional medicine. Patwardhan (2005) argue that in all such attempts, Chinese medicine can help India at various levels, including policies, quality standards, integration practices, research models and integration into the health system. There is no doubt that China has a lot of experience in this arena but it may also be productive



Product description	Turmeric Powder food grade	Turmeric powder capsules	Turmeric high potency tablets	Turmeric rhizome capsules	Turmeric aqueous extract granules	Turmeric SCF extraction softgel capsule	Turmeric organic tincture
Value added	Grinding, packaging	Grinding, encapsulate packaging	Extraction, tableting, packaging	Grinding, encapsulate Complies with BP standard	Extraction freeze drying granulation packaging	SCF extraction, soft gel, packaging	Organic certified, extraction, packaging
Price per kilo	£14.90	£214.75	£665.00	£246.67	£78.00	£1715.83	£179.80 / Litre
Price per daily dose	£0.015	£0.17	£0.33	£0.37	£0.62	£0.69	£1.08

Fig. 4. The value chain for OTC turmeric products found in UK retail outlets.

Table 2
Values of medicinal plants at different stages of supply.

Pinyin drug name	Scientific name	Market price in China (£/kg)	UK supplier price (£/kg)
Bai Zi Ren	<i>Platyclusus orientalis</i> (L.) Franco (Cupressaceae)	6.80	24.60
Bai Shao Yao	<i>Paeonia lactiflora</i> Pall. (Paeoniaceae)	2.00	15.00
Bai Zhu	<i>Atractylodes macrocephala</i> Koidz. (Asteraceae)	4.30	21.80
Bai Xian Pi	<i>Dictamnus dasycarpus</i> Turcz. (Rutaceae)	3.40	19.80
Bai He	<i>Lilium lancifolium</i> Thunb. (Liliaceae)	4.00	30.00
Ban Lan Gen	<i>Isatis tinctoria</i> L. (Brassicaceae)	1.20	7.80
Bo He	<i>Mentha haplocalyx</i> Briq. (Lamiaceae)	1.50	5.80
Cang Zhu	<i>Atractylodes lancea</i> (Thunb) DC. (Asteraceae)	3.10	15.40
Chai Hu	<i>Bupleurum scorzoniferifolium</i> Willd. or <i>Bupleurum chinense</i> DC. (Apiaceae)	5.50	31.40
Che Qian Zi	<i>Plantago asiatica</i> L. (Plantaginaceae)	2.00	9.80
Chen Pi	<i>Citrus reticulata</i> Blanco (Rutaceae)	0.50	5.00
Chi Shao Yao	<i>Paeonia lactiflora</i> Pall. (Paeoniaceae)	2.60	18.00
Ci Wu Jia	<i>Eleutherococcus senticosus</i> (Rupr. & Maxim.) Maxim [syn.: <i>Acanthopanax senticosus</i> Harms.] (Araliaceae)]	0.60	5.00
Da Huang	<i>Rheum palmatum</i> L. or <i>Rheum tanguticum</i> Maxim. ex Balf. and <i>Rheum officinale</i> Baill. (Polygonaceae)	0.50	11.00
Dan Shen	<i>Salvia miltiorrhiza</i> Bge. (Lamiaceae)	1.20	10.00
Dang Shen	<i>Codonopsis pilosula</i> (Franch.) Nannf. (Campanulaceae)	4.60	50.00
Dang Gui	<i>Angelica sinensis</i> (Oliv.) Diels. (Apiaceae)	2.50	23.00
Du Huo	<i>Angelica pubescens</i> Maxim.f. <i>biserrata</i> Shan ex Yuan (Apiaceae)	0.80	32.00
Du Zhong	<i>Eucommia ulmoides</i> Oliv. (Eucommiaceae)	1.60	11.00
Mu Dan Pi	<i>Paeonia suffruticosa</i> Andr. (Paeoniaceae)	2.00	19.00
Mean		2.54	18.3
SD		1.78	11.4

Source: <http://in.reuters.com/article/2010/12/20/india-turmeric-output-idINSGE6BJ04R20101220>.

* Price per kilo of crude powdered turmeric.

Exchange rate £1 = 10 RMB, December 2011.

for India to make collaborations with the countries in which their products are destined in order that they can fully comply with international standards and regulations. Clearly such pharmacoeconomic approaches are another outcome of an understanding of the value chains of Indian and Chinese products entering national and international trade.

5. Examples of current international medicinal plant value chains

Two examples of medicinal plant value chains are described here, one for the practitioner route using values for twenty commonly prescribed herbs used in TCM (Fig. 3, and Table 2) and the other for an over the counter route using a single herbal ingredient, *Curcuma longa* (Turmeric), found chiefly in Traditional Indian medicine, as a case study (Fig. 4). In the first example, the value of the herbs increases dramatically as the product moves away from the farmer and towards the consumer (Fig. 3). The farmers are often the same individuals who sell the botanical drugs in the market. In this example there is no 'value addition' due to processing, as the final product is in the same product – a crude dried herb – as when it started. Therefore, the price increments are due to costs incurred through externalities, price increases through middlemen and value added in terms of professional knowledge.

This is in contrast to the process outlined in Fig. 4 where the over the counter (OTC) products have value added chiefly through different cultivation and processing methods. All of the finished products were purchased from UK retail outlets. Notably there is a ten-fold increase for simply encapsulating the powder for convenience and to give the appearance of a medicinal product rather than a food ingredient. Prices continue to increase as more specialised cultivation and extraction methods are used. Further studies are planned to understand whether there are any differences in chemistry between products.

6. Conclusion

Our central aim in this commentary is to draw attention to some key issues in medicinal plant research/ethnopharmacology, which has largely been overlooked in the scientific debate: the

role of value chains. The literature in this area is often published in NGO and other reports and, therefore, this review cannot be comprehensive. However, it is obvious that in the area of medicinal plant research there is a gap in terms of analysing the value chains which exist for herbal medical products very often harvested from the wild or produced in small scale agricultural practices.

From a pharmacognostic perspective this has crucial implications for the way regulations of such products ought to be developed and on the strategies for quality assurance (esp. as it relates to controlling the overall supply chain). There also is a gap in our understanding on the impact that the gathering or growing of such products has for local household economies and how the benefits are shared (or not shared) throughout the value chain. The conceptual framework we propose in Fig. 1 also helps in understanding the change when local medicinal (and food) plants become global commodities (Heinrich et al., 2011; Obolskiy et al., 2009; Gomez-Castellanosa et al., 2009). The value chains for herbal medicinal products have some unique characteristics, which seem to have had little impact on the discussion about value chains in the socio-economic and developmental politics literature. This is a market often dominated by small and medium sized enterprises, and one which is governed by diverse regulations relating to the products quality and health claims, which vary widely throughout the world (Heinrich et al., 2004). Very often these regulations are relatively stringent (as in the case of the EU's THMPD) but in other cases there is a very limited control over the final products brought to the consumers.

The analytical framework we propose allows an understanding of how the changing pattern of commercialisation changes the value chain, and what impact this has on the various elements of the chain from local producing householders to end user. At the same time, the approach helps us understand the way that changes to value chains may fundamentally change the product and its quality. Conversely product requirements and quality standards as well as other regulatory requirements have an important impact on the value chain. Indeed, the impact of this complex regulatory framework differentiates the value chains of these agricultural and wild-crafted products from other forms of production and distribution.

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