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Competitiveness of sea buckthorn farming in Mongolia: A policy analysis matrix

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Abstract

The perennial shrub sea buckthorn (*Hippophae rhamnoides* L.) provides multiple products that are beneficial to human health. In addition, the plant can also be used to combat desertification. In contrast to the vast ecological, agronomic and nutritional literature on this species, little is known about its economic and marketing aspects, particularly in Central Asia. We therefore analysed the private and social competitiveness of sea buckthorn farming in 21 households of Bulgan county of Khovd province in Mongolia. The results show that half of the interviewed sea buckthorn farmers are privately competitive. We found that social competitiveness exceeded private competitiveness because while private output prices are supported by government policies, which increases private profits, input prices are also supported, which reduces the competitiveness. The net effect of supports to input and output prices taxes producers and reduces private competitiveness. In our study area the most competitive households had larger land sizes, fenced wild sea buckthorn areas, and were more experienced than others. The competitiveness of sea buckthorn farming increased from 2012 to 2013, which may be due to a government subsidy programme. Given the social and environmental benefits of sea buckthorn production, future government programmes should consider supporting the production through subsidies to make private households more competitive.

Keywords: Altay region, Central Asia, farmers' revenue, marketing challenges, private and social competitiveness, production costs

1 Introduction

Sea buckthorn (*Hippophae rhamnoides* L.) is a deciduous shrub that yields intensively coloured orange to red berries. These are rich in Omega 3, 6, 7, and 9 fatty acids, vitamins C, E, A, B, and K, and mineral elements (Zeb, 2004; Suryakumar & Gupta, 2011). The berries provide volatile oil (the most valuable output extracted from the pulp and seeds), juice, and pulp, which are raw materials from which pharmaceuticals, cosmetics, beverages, and other food items are produced, while the residuals can be used for animal feed (Li & Schroeder, 1996). Sea buckthorn grows wildly throughout Asia and Europe and has been planted in North America since the 1930s (Davidson *et al*., 1994; Li & Schroeder, 1996). The species thrives between −43 °C and +40 °C (Rongsen, 1992), in areas with 400–600 mm precipitation (Li & Schroeder, 1996). Five types of therapeutic uses of sea buckthorn are being described as treatment of: cancer (Mingyu, 1994; Zhang, 1989), gastric ulcers (Xing *et al*., 2002), the liver (Gao *et al*., 2003), skin diseases (Zhao, 1994), and cardiovascular diseases (Chai *et al*., 1989). In addition, there are reported human benefits such as balancing the immune system, mitigating coronary heart diseases, and reducing body fat (Zeb, 2004). These benefits make sea buckthorn an exceptionally nutritious and healthy plant even if some reported health effects may lack scientific proof.

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Sea buckthorn is rather resistant to drought (Li & Schroeder, 1996), which makes it suitable to grow in dry areas such as western Mongolia. It can prevent soil erosion and mitigate the effects of desertification on agroecosystems, reduce water loss in the soil, increase options for land reclamation, and it can create habitats for wildlife species. Many of the above mentioned environmental benefits of sea buckthorn are due to its extensive root system (Li & Schroeder, 1996). In NW China sea buckthorn trees have been planted to combat desertification since 1985 (Jianzhong *et al.*, 2008).

Due to its purported health benefits, sea buckthorn has been classified as a "nutraceutical" food crop, which refers to it being both a nutritional supplement and a pharmaceutical drug. Globally the nutraceutical food market is growing rapidly, from an estimated world market volume of US$ 86 billion in 1996 (Nutrition Business Journal cited by Childs, 2000), to US$ 166 billion in 2014 (Transparency Market Research, 2015).

Consumer markets for sea buckthorn products have been established in Asia and Europe. Jianzhong *et al.* (2008) state that 2.7 million hectare of land are cultivated with sea buckthorn in China, the largest area of sea buckthorn worldwide. The same authors also report that China has more than 100 sea buckthorn processing enterprises, and produces about 300 types of sea buckthorn products, with annual production values reaching more than 10 billion RMB (US$ 1.43 billion)[1]. Most of the suppliers of sea buckthorn products that post on international trade websites, such as www.alibaba.com and www.zauba.com, are from China making this country the world's biggest sea buckthorn producer and exporter.

In Mongolia, wild sea buckthorn has been used for centuries for human consumption. In 2013 Oyungerel *et al.* (2015) studied the distribution of wild sea buckthorn in Mongolia (Ministry of Food and Agriculture-MOFA, 2015). They conclude that the species covered about 13,500 hectares of land in Selenge, Bulgan, Zavkhan, Gobi-Altai, Khovd and Uvs provinces in Mongolia. In 2019 sea buckthorn accounted for 1,512 t or roughly 85 % of the total fruit harvest in Mongolia (NSOM, 2020a, Appendix Fig. A.1). Statistical data show that production volumes and values have fluctuated in recent years; after falling considerably from 2011 to 2012, they have increased since (Fig. 1 and 2). Altogether, approximately 64 % of the production took place in Mongolia's western provinces between 2011 and 2019, dominated by Uvs province (53 %) (Appendix Table A.1).

While many studies have been conducted to assess the biochemical, agroecological, and human health effects of sea buckthorn, research is lacking on the economic efficiency and market competitiveness of this species. This is most likely due to the lack of data on production and prices (Storey, 2000), which hinders producers to make informed decisions whether to enter into this business and policy makers on how best to support production.

Against this background, we studied (1) whether the production of sea buckthorn is competitive for private farmers and for the society as a whole in Mongolia, and (2) what policy could be implemented to improve the competitiveness of sea buckthorn. To answer these questions we employed a Policy Analysis Matrix (PAM) approach to survey data collected in Bulgan county of Khovd province in 2014.

2 Materials and methods

2.1 The Policy Analysis Matrix approach

There is no universally accepted definition of competitiveness (Hatzichronoglou, 1996). However, a general consensus among economists regarding the definition of competitiveness may be the OECD's definition reported by Hatzichronoglou (1996, p. 20) whereby competitiveness is *"the ability of companies, industries, regions, nations or supranational regions to generate, while being and remaining exposed to international competition, relatively high factor income and factor employment levels on a sustainable basis"*.

The PAM approach is a quantitative method to analyse the competitiveness of a given production system. The PAM begins with the private perspective: private profit (D) equals revenue (A) minus the costs of tradable inputs (B) and domestic factors (C) evaluated at domestic market prices (Monke & Pearson, 1989, Table 1). A production system (or firm) is privately profitable if D is positive. Private perspective refers to the individual producer such as a farmer who tries to be competitive or profitable in his / her own business. Then (second row of Table 1) social profit (H) is calculated as the difference between revenue (E) and the sum of costs of the tradable inputs (F) and domestic factors (G), all evaluated at social prices. A production system is socially competitive if H is positive. The social perspective refers to whether the production system itself is competitive at the national level irrespective of the individual level, comparing benefits of the production against its costs incurred for the whole society. In the last row of PAM, the divergences between private and social measures of revenue (I), of tradable input costs (J), of domestic factor cost (K), and of profit (L) are calculated. The bigger the divergences, the larger the differences between private and social costs/benefits, and

[1] 1 US$=6.95 RMB, we calculated annual average exchange from daily data in 2008 (State Administration of Foreign Exchange of China, 2020)

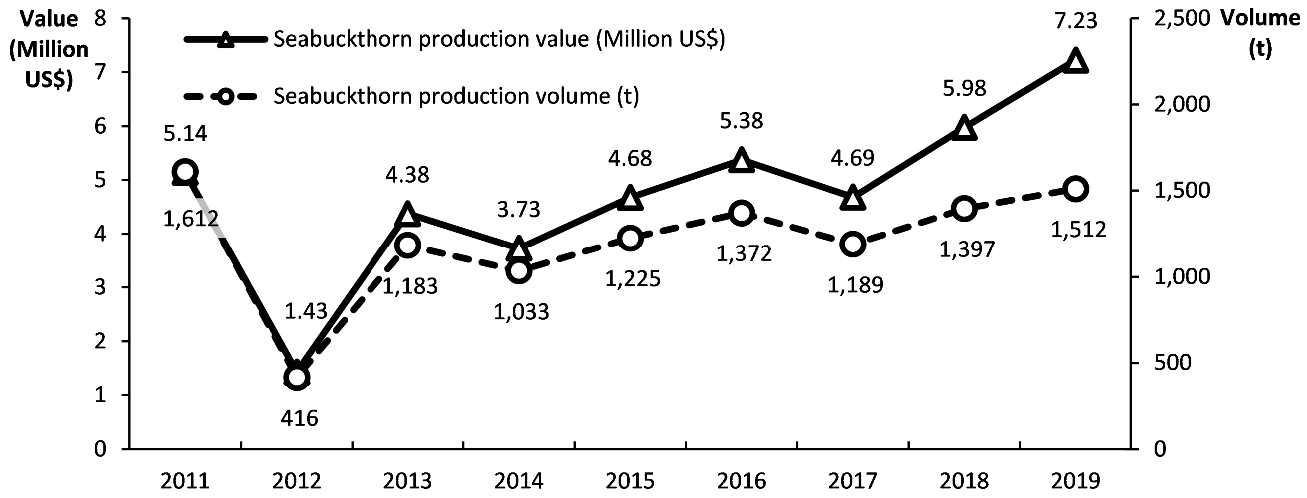

Fig. 1: *Sea buckthorn harvested volumes and market values in Mongolia from 2011 to 2019.*
Source: *National Statistical of Office of Mongolia (NSOM, 2020a) and, Authors' estimation for production value in million US$. The total production value is calculated as harvested quantity multiplied by the national average price. The annual average exchange rate of 2012 is used for converting MNT to US$ (1 US$ =1,359 MNT).*

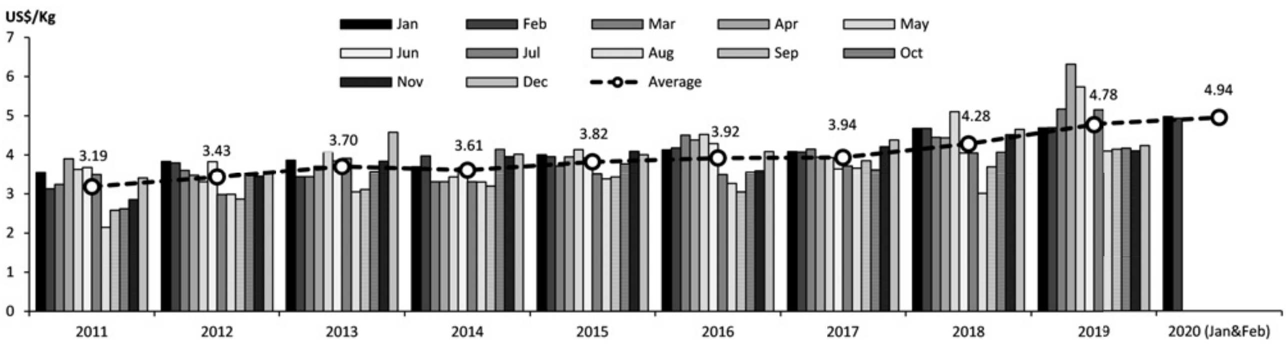

Fig. 2: *Annual average price per kg of sea buckthorn in Mongolia.*
Source: *NSOM (2020b) Unpublished price data.*

the more distorted the incentives that producers face when they make production decisions. Distorted incentives lead to over- or under-use of resources from a social perspective and, thus, to inefficient market outcomes. For example, the government subsidises mineral fertilisers (so that the private costs of fertilisers are lower than their social costs), and this makes production competitive from a private perspective, although it may not be from a social perspective. That is not good from an economic point of view, because it distorts the allocation of resources in the economy – the subsidised fertiliser is essentially being wasted, drawn away from other areas of production where it may generate more added value; furthermore excessive use of fertiliser may generate environmental degradation. This would thus lead to a negative externality as a consequence of market failure. On the other hand, it could be that production causes positive externalities, so that the value of outputs is higher from a social perspective than from a private perspective. Those positive externalities may be environmental (perhaps the above mentioned environmental benefits of sea buckthorn) or social (perhaps the cultivation of sea buckthorn provides employment in remote regions that might otherwise fall below a critical level of economic activity, leading to depopulation). In that case the divergence is not caused by a government distortion of prices, but rather by the lack of an appropriate government policy to correct the divergence and bring private prices into alignment with social prices.

Private prices for tradable outputs (P_i^p) and inputs (P_j^p) are market prices. Social prices for tradable output (P_i^s) and input (P_j^s) are CIF (Cost, Insurance, and Freight) import prices or FOB (Free on Board) export prices, because these prices represent the social opportunity costs of purchasing/selling the products in question. As Monke & Pearson (1989) noted, producing a unit of tradable output saves the cost of importing it from abroad, or increases the export revenues that a country can acquire. Similarly, using tradable input in-

Table 1: *Policy Analysis Matrix used to assess the competitiveness of sea buckthorn in Western Mongolia.*

	Revenues	*Cost*		*Profit*
		Tradable Inputs	*Domestic Factors*	
Private Prices	$A = P_i^p$	$B = \sum_{j=1}^{k} a_{ij} P_j^p$	$C = \sum_{j=k+1}^{n} a_{ij} V_j^p$	$D = A - B - C$
Social Prices	$E = P_i^s$	$F = \sum_{j=1}^{k} a_{ij} P_j^s$	$G = \sum_{j=k+1}^{n} a_{ij} V_j^s$	$H = E - F - G$
Divergences	$I = A - E$	$J = B - F$	$K = C - G$	$L = D - H == I - J - K$

Source: Monke & Pearson(1989); adapted from von Cramon-Taubadel & Nivyevskyi (2009, p.104).
The subscript i refers to outputs and j refers to inputs
a_{ij} - for (j=1 to k) are technical coefficients for traded inputs in the production of i
a_{ij} - for (j=k+1 to n) are technical coefficients for domestic factors in production of i
P_i^p - is the price of output i: *=p private price; *=s social price
P_j^p - is the price of traded input j; *=p private price; *=s social price
V_j^p - is the price of domestic input j; *=p private price; *=s social price.
$A, B, C, D(E, F, G, H)$ represent revenue, cost of tradable inputs, cost of domestic factors, and profit in private (social) perspective, respectively, and I,J,K,L represent divergences between private and social revenue, cost of tradable inputs, cost of domestic factors, and profit respectively.

creases the cost of importing it or reduces the revenues that could be obtained by exporting it. Private (market) and social prices may differ because of government policies such as an import duty that raises the domestic market price that producers pay for an input, or receive for an output, above the corresponding FOB or CIF border price. Such divergence will distort production incentives, leading from a social perspective to an underuse of the input and overproduction of the output, respectively.

The evaluation of non-tradable domestic factors is less straightforward. Private prices for domestic factors (V_j^p) are market wages for labour, rent for land, and interest rates on capital. However, domestic market prices do not necessarily capture the social benefits and costs of the domestic input use. For example, using pesticides purchased at market price may be cheap for the farmer to operate low private cost, although it may be harmful for the environment, so that the social cost may be higher than the private cost.

2.2 Competitiveness indicators

The PAM can be used to derive several ratios that make it possible to compare the competitiveness of production systems. The private cost ratio, $PCR = C/(A - B)$, is the ratio of the cost of domestic factors to value added, evaluated at private prices. Private firms generally try to minimize their *PCR*s by reducing B and C while increasing A to maximize their profit. The domestic resource cost ratio, $DRC = G/(E - F)$, compares the cost of domestic factors to value added evaluated at social prices. If $0 < DRC < 1$, then the production is socially competitive because the social value added per unit of production is greater than the social cost of domestic inputs used to produce that unit (Gorton & Davidova, 2001). If $DRC < 0$ or $DRC > 1$, then production is not socially competitive.

Alternatively, researchers use private (PCB) and social (SCB) cost benefit ratios. The PCB (SCB) shows the competitiveness of the commodity from a private (social) perspective. It measures the ratio of the sum of the costs of tradable and domestic inputs evaluated at private (social) prices to the total revenue of the good evaluated at private (social) prices: ($PCB = (B + C)/A$ and $SCB = (F + G)/E$). PCB (SCB) never fall below zero. A value between zero and one indicates that the costs in the numerator are less than the revenue in the denominator, i.e. that the commodity is produced competitively from a private (social) perspective. Since the *DRC* is discontinuous at zero and sensitive to the categorization of inputs as either domestic or tradable (Masters & Winter-Nelson, 1995; Nivievskyi & Cramon-Taubadel, 2009), we focus in the following on PCB and SCB ratios.

Most PAM analysts use national or regional average data to measure the costs and revenues of a production system. However, averages ignore the fact that not all producers work under identical conditions. Hence, they cannot generate insights into the best/worst practices and the distribution of competitiveness across producers (Morrison

& Balcombe, 2002; Cramon-Taubadel & Nivyevskyi, 2008, and 2009). Following Cramon-Taubadel & Nivyevskyi (2008), we estimated competitiveness indicators at the individual producer's level, but not at the national level, to present results on the distribution of competitiveness and the characteristics of producers who are more/less competitive.

2.3 *Study site*

In June 2014 we surveyed 21 sea buckthorn farming households (HHs) in Bulgan county, Khovd province in Mongolia for data of 2012 and 2013. The environmental conditions, including soil, precipitation and temperature, in Khovd province are similar to those of Uvs province (Western Mongolia), which is the country´s major sea buckthorn producing province. Both areas are part of the Dzungarian Basin, a semi-desertic and mountainous region bordering China. We defined sea buckthorn farming as production by a household (HH) that either plants sea buckthorn on its land, or owns (or 'leases') land on which sea buckthorn grows wildly. The Bulgan County Administration Office provided us with a list of all known 56 sea buckthorn farming HHs in the county. To generate panel data we selected those HHs that had harvested sea buckthorn berry (SBB) in both 2012 and 2013, and omitted 26 HHs which had only harvested in one of those years. Since nine HHs were not at home when the survey team visited, we were left with a total of 21 HHs.

2.4 *Input cost estimations*

We considered 22 types of inputs for sea buckthorn production, divided into non-tradable and tradable inputs from interviews (Table 2).

The non-tradable fixed inputs include four types of inputs: irrigation canals, fences, seedlings, and other inputs (shovels, grub axes and hoes, animal dung, plastic water tubes, crowbars, pots, and scythes). We used relevant sources to get useful lives and salvage values for these fixed inputs (Appendix Table B.2). To estimate the social price of non-tradable intermediate inputs, we used the 'Standard Conversion Factor' (SCF) as proposed by Squire & van der Tak (1975; Appendix 2). We calculated the SCF as 0.919 and 0.914 for 2012 and 2013, meaning that (when SCF is less than 1) the social price would be less than the domestic price (Appendix Table B.2). This means that a farmer would earn greater income from selling his/her sea buckthorn in the domestic market than in the international market, as an assumption of using SCF. There could be several reasons for this including that domestic resources for sea buckthorn production are more expensive than in the international market.

The 'capital recovery factor (crf)' is used to estimate the annual cost of non-tradable fixed inputs such as irrigation canals, fences, and seedlings (Monke & Pearson, 1989). The difference between the total initial cost of the fixed input (Z) and the salvage value (S) is depreciated by the crf, which is the square-bracketed term in the equation below (Eq. 1). This is used to obtain Q, which is the 'annual payment sufficient to repay' the initial cost of a fixed input.

$$Q = (Z - S)\left[\frac{(1+i)^n i)}{(1+i)^n - 1)}\right] \quad (1)$$

In Eq. 1, the interest rate (i) and useful life (n) of the input are the factors used to depreciate the cost to the present time period.

We took the annual average interest rate of Mongolia as the private interest rate (rate of return). This rate was 18.1 % in 2012 and 18.5 % in 2013 (World Bank, 2016). For the social interest rate, there was no estimation for the Mongolian context, hence we choose the annual average interest rate of Georgia, because the GDP per capita and population size of Georgia and Mongolia is close, and both are under a post-planned, transition economy under a semi-presidential and republic constitution. Monke & Pearson (1989) proposed this method based on the assumption that higher income countries (measured by GDP per capita) are generally characterised by a lower rate of return to capital. Based on this assumption the social interest rate was 14.8 % in 2012 and 13.6 % in 2013 (World Bank, 2016).

Labour is a non-tradable intermediate input for sea buckthorn production, as there is limited access to the international labour market in Bulgan county. In vast rural areas such as Bulgan county, there are limited job opportunities and family labour is typically unpaid. Thus, there is no salary data for sea buckthorn farmers. Hence, we assumed that the private price of the labour for sea buckthorn farming equals the national poverty line (NSOM, July 1, 2015), which was US$ 2.9 per person and day in 2012 and 2013. This was converted by the SCF to estimate the social salary (US$ 2.66 in 2012, and US$ 2.67 in 2013)[2]. This could mean that a farmer would receive higher earnings if he/she works in his/her own farm than working in someone else's farm, because there is lack of job opportunities in remote areas. The five types of tradable inputs identified for sea buckthorn production included: vehicle fuel, sugar, plastic bags, buckets, and gloves, all imported from China (Table 2). To measure the private prices of tradable inputs, we used the purchase prices reported by the surveyed HHs, and NSOM price data for Khovd province to replace missing values. For social

[2]Estimation was based on the poverty line (118,490 MNT in 2012 per person per month) measured in months, which is then divided into 30 days to estimate the price of labour per person per day. 1 US$=1,359.24 MNT, average exchange rate of 2012 reported by the Central Bank of Mongolia.

Table 2: *Inputs of sea buckthorn farming in Bulgan county, Western Mongolia.*

№	*Inputs*		*Types*	*Subtypes*
1	Non-tradable fixed inputs		Building irrigation canal	
2			Building fence	
3			Seedlings	
4			Other investment items	
5	Non-tradable intermediate inputs	Capital	Storing cost	Freezing
6			Cost of selling the sea buckthorn	Transportation
7			Other intermediates	Improving the net of the fence
8			Sea buckthorn loan interest rate	
9		Labour	Labour for harvesting	
10			Labour for selling	
11			Labour for sea buckthorn maintenance	Mowing
12				Pest control and rousing birds
13				Maintaining the fences
14				Cleaning the sea buckthorn tree area
15			Watering the sea buckthorn trees	
16		Land	Annual land tax	
17	Tradable intermediate inputs	Capital	Storing cost	Vehicle fuel
18				Sugar
19			Cost of selling the sea buckthorn	Plastic bags
20				Vehicle fuel
21			Other intermediates	Buckets
22			Gloves	

prices, we used the calculated unit import prices of these inputs based on data reported by the Custom Agency of Mongolia (2015).

We asked HHs to indicate whether they agreed with statements that describe seven types of challenges to sea buckthorn farming. Respondents were encouraged to reveal their level of agreement with each statement on a Likert Scale, with strongly disagree=1, disagree=2, neutral=3, agree=4 and strongly agree=5.

3 Results

3.1 Data description

An average sea buckthorn farming HH had 4.6 (±1.6) family members. The average age of the HH head was 47 (±11), and he/she has received 10 (±2.4) years of formal education[3]. Although sea buckthorn has been harvested in the wild for centuries, sea buckthorn planting is a relatively new farming activity in Mongolia. Roughly, half of the HHs in our sample fenced wild sea buckthorn areas. These HHs had on average 16.3 years (min. 4 and max. 55) of experience with sea buckthorn farming. In contrast, the average HH that actively planted sea buckthorn had about 5.5 years (min. 3 and max. 9) of experience with sea buckthorn farming.

Thirteen HHs planted three types of sea buckthorn: wild (58 %), Chinese (17 %), and domestic varieties from Uvs and Khovd provinces (25 %). The wild type was transplanted by the HHs themselves as they took younger seedlings from natural stands found along the Bulgan river valley and planted them on their own land. The average HH harvested about 444 kg sea buckthorn in 2012 and 467 kg in 2013 (Table 3). However, there was a significant difference between the HH types. Based on the size of the average annual harvest we defined a sea buckthorn farming HH as small (below 99 kg), medium (between 100 and 200 kg), and large (above 201 kg).

The average price of SBB was US$ 3.1 and US$ 3.3 per kg in 2012 and 2013, which is slightly lower than the national

[3]Standard deviation in brackets

Table 3: *Descriptive statistics of harvested volume and price of sea buckthorn in Bulgan county, Western Mongolia.*

Indicator	*HH type*	*Obs.**	*2012*				*2013*			
			Mean	*±SD*	*Min*	*Max*	*Mean*	*±SD*	*Min*	*Max*
Harvested volume of sea buckthorn per HH (kg)	Small	8	27.1	14.7	7.0	50.0	30.6	9.4	15.0	40.0
	Medium	4	125.0	50.0	100.0	200.0	175.0	50.0	100.0	200.0
	Large	9	956.1	978.4	300.0	3,500.0	985.6	939.1	210.0	3,000.0
	Overall	21	443.9	768.9	7.0	3,500.0	467.4	753.2	15.0	3,000.0
Price per kg of SBB (US$)	Private	21	3.1	0.6	1.8	4.4	3.3	0.6	2.2	4.4
	Social	21	2.8	0.5	1.7	4.1	3.0	0.5	2.0	4.0

* Number of observations for different household (HH) types were equal in both years, but one HH shifted from medium to large and one HH shifted from large to medium size.

average (Fig. 2). The estimated social price of SBB was US$ 2.8 and US$ 3.0 in 2012 and 2013.

3.2 *Revenues, costs, and profits*

From the sample, an average household incurred losses in both years (Table 4). However, the profitability level was different for each HH type. For example, an average large size HH shifted from loss in 2012 to profit in 2013, which was not the case for small and medium HHs. Several aspects of these results are important.

First, social revenue was lower than private revenue – the government supported output prices which boosted profitability. The lower social price means that the domestic producers were supported by government policies. This suggests that domestic producers were charging higher prices from consumers, which was mostly due to import restrictions and tariff policies. However, the largest sea buckthorn producer, China, may have higher government subsidies for sea buckthorn production (Jianzhong *et al.*, 2008). Hence the Chinese export price (social price for Mongolia) was likely lower than the Mongolian domestic price. In other words, our results reflect the fact that the international (social) price was lower than the domestic (private) price.

Mongolian sea buckthorn production would probably be more competitive if China did not subsidise its production. It is to be noted that we used world market prices to measure the social value of the output. If the world market price was dominated (and distorted) by subsidies provided in China, that may be unfair from a Mongolian perspective (i.e. without the Chinese subsidies Mongolian production would be more competitive). However, this does not change the fact that rather than producing sea buckthorn, Mongolia could import it at the Chinese price. If Mongolia could prove that China is dumping sea buckthorn on the market, then it could take the case to the World Trade Organization (WTO). However, before taking up the case, Mongolia would have to remove its own input price distortions.

Second, social costs were also lower than private costs – the government also supported input prices, which reduced profitability. This means that the domestic producers were encountering the disadvantage of having higher costs of production compared with international prices. The cost of capital in Mongolia is high due to high deposit interest rate and a risk premium. Compared with China, Mongolia also has a cost disadvantage given the much smaller size of the sea buckthorn stands and national market, which may cause a low level of return for Mongolia. For instance, it could be the case that China experiences an advantage of low labour costs (Ceglowski & Golub, 2012), and subsidy-based policy for sea buckthorn farmers (Jianzhong *et al.*, 2008).

From a private perspective the average HH spent annually about US$ 1,091 in 2012 and US$ 1,175 in 2013 on sea buckthorn production (Table 5). Fixed and labour costs contributed most costs compared to capital and land, although capital and labour costs were close to each other. Both private and social costs increased but increase of income was higher than cost growth, which caused the profit to increase in 2013 compared to 2012.

Third, the net effect of the above mentioned two distortions generated the gap between private and social profitability. Overall, in both years the profitability, both in the private and the social perspective, was negative, meaning that sea buckthorn production was on average not profitable. The sea buckthorn production system was socially more competitive as the social loss was less than the private loss (Table 4). The data revealed that the government policy for input support (second effect) was higher than the output support (first effect). The implications are that the sea buckthorn price was protected (or supported), however, the prices of inputs to produce the crop were even more protected (thus higher). Hence, private sea buckthorn farmers are in need of support

Table 4: *Annual average revenues, costs and profits (in US$) per kg of SBB of different household (HH) types in Bulgan county, Western Mongolia.*

Price Category	*HH type*	*Obs.**	*2012*			*2013*		
			Revenue	*Cost*	*Profit*	*Revenue*	*Cost*	*Profit*
Private	Small	8	3.25	6.75	-3.50	3.42	5.04	-1.61
	Medium	4	3.16	3.42	-0.26	2.94	2.96	-0.02
	Large	9	2.90	3.41	-0.51	3.31	2.88	0.43
	Overall	21	3.08	4.69	-1.60	3.28	3.72	-0.43
Social	Small	8	2.99	5.92	-2.94	3.13	4.22	-1.09
	Medium	4	2.91	2.99	-0.08	2.68	2.53	0.16
	Large	9	2.67	2.97	-0.31	3.03	2.40	0.63
	Overall	21	2.83	4.10	-1.27	3.00	3.12	-0.12

* Number of observations for different household (HH) types were equal in both years, but one HH shifted from medium to large and one HH shifted from large to medium size.

Table 5: *Annual cost (in US$) of sea buckthorn production in households of Bulgan county, Western Mongolia in 2012 and 2013.*

Cost type	*2012*				*2013*			
	Private		*Social*		*Private*		*Social*	
	Mean±STD	*(Min-Max)*	*Mean±STD*	*(Min-Max)*	*Mean±STD*	*(Min-Max)*	*Mean±STD*	*(Min-Max)*
Domestic Factor								
Fixed input	406±906	(19-3929)	339±751	(17-3255)	415±925	(20-4011)	315±695	(16-3015)
Capital	274±972	(0-4429)	251±893	(0-4070)	273±979	(0-4458)	249±895	(0-4075)
Labour	298±283	(17-935)	274±260	(15-859)	355±418	(21-1555)	324±383	(20-1421)
Land	68±113	(0-471)	62±104	(0-433)	68±113	(0-471)	62±103	(0-430)
Tradable input	45±87	(0-317)	29±55	(0-197)	65±155	(0-666)	34±70	(0-243)
Total	1091±2151	(57-9768)	956±1894	(51-8619)	1175±2352	(63-10510)	984±1992	(53-8949)

to decrease their input costs for production such as interest rate for loans and vehicle fuel to improve private competitiveness. From a social point of view, eliminating all price distortions (subsidies or supports) would be a recommendable policy option. Consequently, the consumers would not suffer from high prices, and producers would not be dragged down by high input costs.

3.3 Competitiveness

The estimated density points depicted between 0 and 1 show the distribution of competitive HHs, and more than 1 reflects non-competitive HHs (Fig. 3).

The distribution is left-skewed, with a long tail to the right, suggesting that some HHs were very uncompetitive, both at private and at social prices. The divergence between private and social competitiveness, based on PCB and SCB ratio distributions, was small. This suggests that the effects of the output and input price divergences discussed above largely cancel out. Generally, the competitiveness level has increased from 2012 to 2013.

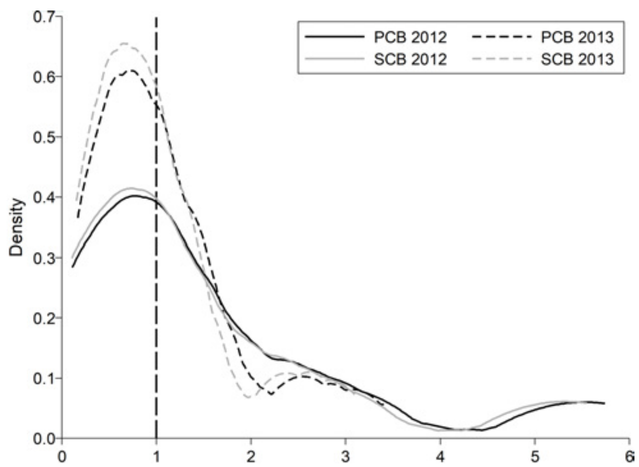

Fig. 3: *Kernel density of private cost benefit (PCB) and social cost benefit (SCB) ratios of sea buckthorn production in Bulgan county, Western Mongolia.*

Nivievskyi & Cramon-Taubadel (2009) introduced three types of proportions to analyse the competitiveness level of production systems. First, the proportion of total production volume (PTP) measures the percentage of production volume produced by competitive/non-competitive HHs. Second, the proportion of the total number of farmers (PTF) measures whether the percentage of sampled households are competitive/non-competitive. Third, the proportion to total output value (PTOV) measures the percentage of total revenue generated by competitive/non-competitive households.

Average PCB and SCB ratios are above 1 (Table 6), which confirmed that in 2012 on average sea buckthorn production was not competitive. However, 47.6 % and 52.4 % of the HHs were privately competitive or profitable in 2012 and 2013, and these HHs accounted for roughly 80.4 % and 61.0 % of the total production volume and 84.3 % and 66.2 % of the total sea buckthorn revenue in the sample in 2012 and 2013, respectively.

While PTF increased (only one farmer shifted from the non-competitive to the competitive status in 2013), both PTP and PTOV actually fell (less of the production was competitive in 2013). This was because small and large competitive HHs reduced their production on average; conversely, non-competitive HHs increased the production. As a net effect, average competitive HHs reduced their production while non-competitive HHs increased their production volume. This may imply that non-competitive HHs increased their production that allowed them to reduce unit cost and increase revenue, essentially to operate competitively.

Competitiveness differed only slightly between the private and social perspectives, which is because the gap between private and social prices of the outputs and inputs was minimal. Overall, private competitiveness level was lower than social competitiveness in both years and for all three proportions (Table 6). The private and social competitiveness levels increased from 2012 to 2013. This was partially due to the increased harvest volume and the increased sea buckthorn price in 2013, which allowed revenues to grow faster than costs. It might also be traced to the implementation of the "Sea Buckthorn National Programme (SBNP)" by the Government of Mongolia which aimed at supporting the sea buckthorn industry. The SBNP was scheduled to be in effect from 2010 to 2016, and resulted in government expenditure of 19.3 billion MNT (US$ 10.6 million) by the end of 2014 (MOFA, 2015). About one third of the funding from SBNP was spent for production and distribution of sea buckthorn seedlings. Furthermore, SBNP provided support for the establishment of sea buckthorn processing factories, irrigation systems, a plantation station for seedlings, research, training, and advocacy. MOFA (2015) stated that from 2010 to 2014 SBNP enabled 6.4 million sea buckthorn seedlings to be prepared and distributed, employing 6,048 people and protecting 20,000 hectares of land from desertification. The SBNP may thus have had a positive impact on improving the competitiveness of sea buckthorn production in Mongolia.

3.4 *Comparison of the most and the least competitive households*

We defined the most and least competitive HHs as those that ranked at the top or at the bottom using the PCB ratio over the two study years. Using this criterion, six most competitive HHs and five least competitive HHs were identified and compared (Table 7).

On average, the most competitive HHs tended to have larger land and fenced wild natural sea buckthorn areas instead of establishing a plantation. They were more experienced, had larger families, a younger household head, and a higher productivity per female sea buckthorn tree than the least competitive households.

3.5 *Challenges for sea buckthorn farming*

About half of the sea buckthorn farming HHs in our sample were not competitive from both a private and a social perspective. Our survey results revealed that many HHs felt exposed to numerous challenges associated with sea buckthorn farming (Fig. 4).

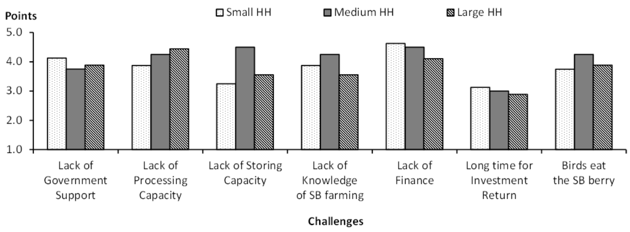

Fig. 4: *Challenges for sea buckthorn farming in Bulgan county, Western Mongolia.*
Note: *On the y-axis: (5) strong disagreement. (4) disagreement. (3) neutral. (2) agreement. (1) strongly agreement. SB = sea buckthorn.*

Overall, the HH perceived a lack of finance as the most serious challenge for sea buckthorn farmers. This was supported by our analysis showing that 37.2 % (2012) and 35.3 % (2013) of total private costs referred to fixed input costs (Table 5). A lack of processing capacity was the second most important challenge overall, and was perceived by large producers to be the most serious challenge. Presumably, these HHs are more efficient at producing sea buckthorn, so their biggest concern was marketing and receiving a good

Table 6: *Private cost benefit (PCB) and social cost benefit (SCB) ratios of sea buckthorn production in Bulgan county, Western Mongolia.*

Proportions	*2012*						*2013*					
	PCB		*SCB*		*Average*		*PCB*		*SCB*		*Average*	
	0<PCB<1	*PCB>1*	*0<SCB<1*	*SCB>1*	*PCB*	*SCB*	*0<PCB<1*	*PCB>1*	*0<SCB<1*	*SCB>1*	*PCB*	*SCB*
PTP	80.4%	19.6%	81.5%	18.5%			61.0%	39.0%	63.5%	36.5%		
PTF	47.6%	52.4%	52.4%	47.6%	1.6	1.5	52.4%	47.6%	61.9%	38.1%	1.1	1.0
PTOV	84.3%	15.7%	85.3%	14.7%			66.2%	33.8%	68.9%	31.1%		

Note: PTP-Proportion of total production volume; PTF-Proportion of the total number of farmers; PTOV-Proportion of total output value (revenue; after Nivievskyi & Cramon-Taubadel, 2009).

Table 7: *Comparison of the most and the least competitive households of sea buckthorn production in Bulgan county, Western Mongolia.*

№	*Indicators*	*Measurement unit*	*Most competitive HHs*	*Least competitive HHs*
1	Number of HHs	Number	6.0	*5.0
2	Land size	Ha	5.3	4.2
3	Wild sea buckthorn farmer	1=Yes, 0=No	0.7	0.0
4	Experience of sea buckthorn farming	Years	8.8	6.0
5	Family size	Persons	5.0	4.8
6	Age of household head	Years	46.0	46.2
7	Total volume of harvested sea buckthorn in 2013	kg	820.0	638.0
8	Sea buckthorn productivity per female tree	kg	6.9	4.8

* One household was dropped from the comparison because of the old age of the household head.

price for their output. If there was a processing facility in the region, then the sea buckthorn price of the farm gate would be higher based on interviews. Some HHs complained about the birds that eat the sea buckthorn, which often reduced the harvest volume and increased costs for materials to protect sea buckthorn from the birds.

4 Discussion and Conclusions

In Mongolia, planting and harvesting sea buckthorn is a new way of farming, contrasting with the traditional way of simply harvesting the berries from the wild. Sea buckthorn farming benefits the environment by combatting desertification and it generates income for poor rural households. However, the methodology used lacks an in-debt analysis of externalities of sea buckthorn production, which merits future research. Our data, nevertheless indicate that the private competitiveness level was lower than the social one. This may have been affected by the assumption of using SCF to estimate social output and input prices.

Our analysis of disaggregated data indicated that although an average household run sea buckthorn production at a loss, about half of the households operated with profit, both from the private and social perspective. Lacking experience in sea buckthorn farming is likely one cause for this, as the average experience of a sea buckthorn plantation was only 5.5 years.

The most competitive households had larger farm land, and fenced a wild sea buckthorn area instead of planting new trees, they were also more experienced and obtained a higher yield per female tree than the least competitive households. Challenges that reduced the competitiveness of the sea buckthorn farmers were lack of finance, especially for small households, and processing capacity, and experience, which all were revealed from the household interviews.

From a managerial viewpoint, our data indicate that households experienced in handling a fenced, wild sea buckthorn area are more competitive than households relying on planting of trees as fencing and subsequent harvest of wild sea buckthorn areas results in cost saving and higher productivity per female tree.

In theory, to improve private competitiveness, government policies should focus towards decreasing the costs of inputs. To improve social competitiveness, price supports both for inputs and output should be eliminated, so that the consumers will not suffer from high output price and farmers will not be burdened with high input costs. The SBNP is a typical example of supporting planting sea buckthorn to counter desertification, which is a well known strategy in China. Such policies should also support approaches to reduce production costs of sea buckthorn by directly or indirectly subsidizing output prices given that the plant itself has undisputed social and environmental benefits. Profitability of production will also increase once there are effective equipment to chase birds away from production areas of sea buckthorn and by using machines to harvest the berries from the shrubs.

Given the described positive externalities of sea buckthorn cultivation in the Altay Region of Mongolia such as avoidance of soil degradation and income generation from berry processing in remote areas, the Mongolian government's current output subsidies make sense at the societal level. In this, however, it is contradictory that existing policies at the same time distort input prices such as by excessive credit costs, a practice that should be modified. If that was accomplished, the isolated effect of the output price support alone may be sufficient to make production privately profitable, so that it increases and society can benefit more from the positive externalities of sea buckthorn production and berry marketing.

Supplement

The supplement related to this article is available online on the same landing page at: https://doi.org/10.17170/kobra-202004061144 .

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Conflict of interest

Authors state they have no conflict of interest.

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