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China´s Corn Production – Where to establish agri benchmark Farms in Corn

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1 Introduction

Corn is one of the very important and politically sensitive crops in China, especially since China has become a net importer of corn. Thus, the question has arisen as to whether and under what conditions China could increase its corn production. Since China is anticipating a major increase in domestic food and animal protein demand in general, any such increase in domestic production has to come mainly from growth in productivity on existing corn acreage.

Against this background, ***agri benchmark*** Cash Crop is keen to explore the status quo of corn production and the potentials for yield increases.

This report has been set up in order to identify relevant regions for the creation of such farms. Relevant regions shall share one or more of the following criteria:

(1) The regional corn production is important for China.
(2) The regional corn production has been increasing over the last decade – both in terms of acreage and in terms of yield per hectare.
(3) Regions appearing to differ significantly with regards to agronomical and/or economic conditions such as:
    (a) Double cropping vs. annual cropping seasons
    (b) Irrigation vs. non-irrigation
    (c) High vs. low land rents
    (d) Farm size
    (e) Input intensity of corn production

In the following, the reader will find an overview of those parameters for key Chinese corn production regions.

2 Evolution of Chinese grain acreage, yield and prices

2.1 Acreage of three main grain crops

Land area dedicated to three key crops - rice, corn and wheat - has changed since 1990 significantly. Cropland dedicated to rice and wheat

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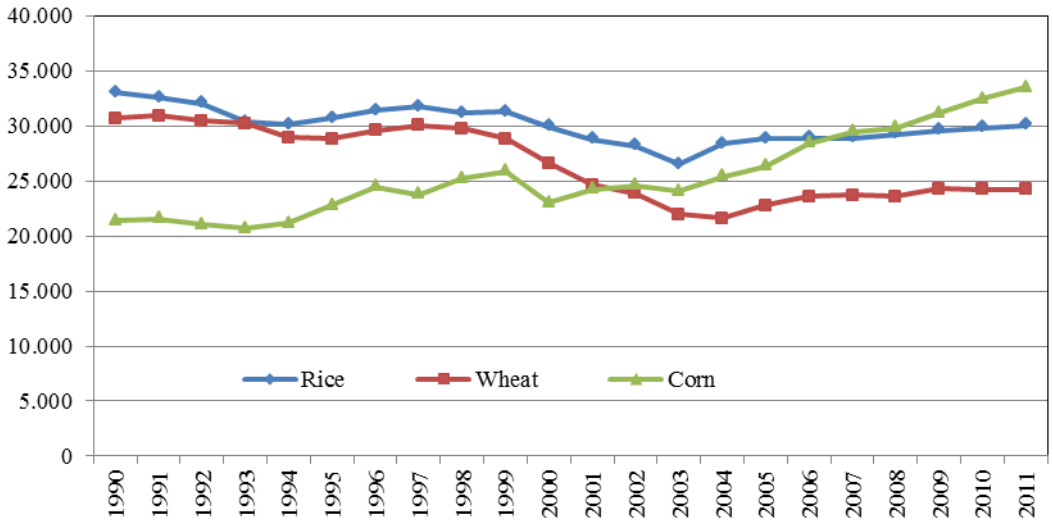
has decreased while the land area dedicated to growing corn has increased dramatically. In the time span from 1990 to 2011, 9.5 million hectares of cropland were no longer planted in rice and wheat while the number of hectares dedicated to growing corn increased by 12.1 million during this same period. The cropland dedicated to growing corn is bound to continue increasing after 2011 due to the high demand for feed.

Figure 1: Rice, wheat & corn acreage (1990 – 2011, in 1,000 ha)

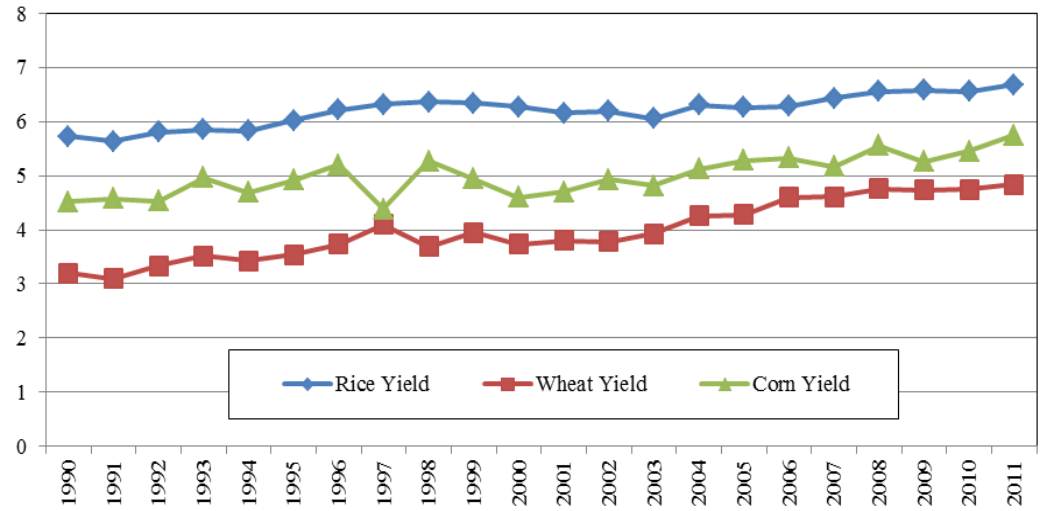


Source: China Statistics Yearbook 2012

2.2 Evolution of yields of three main grain crops

Yields for grain crops have increased from 1990 to 2011. Corn yields lie on average between rice yields and wheat yields. Corn yields increased from 4.5 t/ha to 5.75 t/ha (+0.9 % p.a.); however, the increase in wheat yields was stronger when looking at the annual change (+2 % p.a.).

Figure 2: Yields of three main grain crops (1990 to 2011; t/ha)

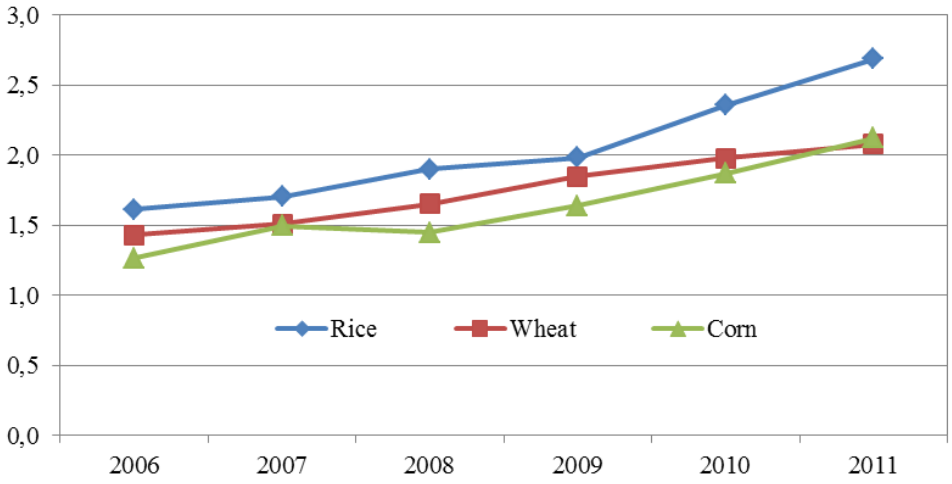


Source: China Statistics Yearbook 2012

2.3 Evolution of corn, wheat and rice prices

The annual growth rate of corn prices was 9.6 %, a figure higher than that for wheat (7.9 %). As a result now wheat and corn prices are at the same level. Previously, as in global markets, corn was priced lower than wheat.

Figure 3: Rice, wheat and corn prices (2006 to 2011; ¥/kg)



Source: National Development and Reform Commission 2012

Thus, we can conclude that the new price ratio is creating a slight boost for corn in relation to wheat. Taking into account the advantage in corn yields relative to wheat, growers, who in principle could grow either of the

two crops, were economically incentivized to expand their corn production and reduce their wheat acreage or any other crop at the same economic performance level.

There are two main drivers for this development in price ratio: on the one hand, there are very often serious quality issues with wheat – mainly due to wet harvest and poor drying conditions; hence wheat prices are low. One main reason why wheat is grown under such unfavorable conditions is government order to regional governments. Secondly, many livestock producers are not used to feed wheat to their animals; therefore they are purchasing corn rather inelastically – even when it becomes expensive relative to wheat.

3 China’s Corn Belt

The top eleven provinces in corn acreage and production create China’s Corn Belt (see Figure 4). The Corn Belt stretches from northeast to southwest across China. This part of the country is characterized by a rather high share of corn in the rotation – on average corn accounts for about 1/3 of the acreage. In a few regions this share goes up to about 50 % or more. There seems to be a tendency whereas the share of corn is higher the greater size of the total provincial acreage – and vice versa. The corn acreage of the top 11 provinces accounted for 81% of the total corn acreage while the corn production of the top 11 provinces accounted for 83.1% of the total corn production.

The Chinese Corn Belt can be divided into three regions which to a certain degree can be described by distinct natural and agronomical conditions as far as corn production is concerned (see Table 1):

Region 1, The Northeastern spring corn region (Upper part of Corn Belt) includes the provinces Heilongjiang, Jilin, Liaoning and Inner Mongolia.

Region 2, The Huang river-Huai river-Hai river summer corn region (Central part of Corn Belt) includes the provinces Hebei, Henan, Shandong and Shanxi.

Region 3, The Southwest mountainous area corn region (Lower part of Corn Belt) includes the provinces Shaanxi, Sichuan and Yunnan.

Figure 4: The Chinese Corn Belt

Source: China Statistics Yearbook 2012

4 Framework conditions for corn production in Corn Belt provinces

Before looking at more detailed figures about the corn production in the Corn Belt some more general background information about the climatic and agronomical framework conditions for corn production are displayed here.

As can be seen from Table 1, the three regions differ in particular about the intensity of crop production: In the North-East (region 1) there is just one crop per year and corn – together with soybeans – is the dominating crop. Inner Mongolia is the only major province in this comparison in which corn is dominantly irrigated. In region 2, precipitation is significantly higher and double cropping is important. Finally, region 3 is characterized by even higher precipitation and a next step in cropping intensity: in many parts of the region three crops per year can be realized. Region 3 is also much more divers in terms of crops that are grown; rice and potatoes are crops that are being produced together with corn.

Table 1: Framework conditions for corn production in Corn Belt provinces

North-East spring corn region (Region1)	
	Characteristics
Provinces	Heilongjiang, Jilin, Liaoning and Inner Mongolia
Growing season	Sowing seeds (Apr.), Harvest (Sept.)
Water supply	Inner Mongolia uses irrigation. The rest is rain fed. Precipitation: 400-800 mm; mainly between July and Sept.
Soil	Black soil and brown soil
Rotation	One crop per year. Corn continuous cropping (50% acreage) Corn-Soybean (40% acreage)
Machinery	The farmland is flat and wide, so mechanization is very high. This region is highly adaptable to large machines
Huang river-Huai river-Hai river summer corn region (Region2)	
	Characteristics
Provinces	Hebei, Henan, Shandong and Shanxi
Growing season	Seeding: Mid of June; harvest end of Sept.
Water supply	Rain fed, Precipitation: 600-900 mm occurs mainly during summer.
Soil	It is very variable in different parts of this region, but it is mainly brown soil and cinnamon soil.
Rotation	Typical rotation is two crops (corn-wheat) per year.
Machinery	It is mainly flat, so the mechanization is also very high. Farms are smaller than in the northeast. There is potential to use large machinery in this region.

cont'd: Table 1: Characteristics of corn production in Corn Belt provinces

Southwest mountainous area corn region (Region3)	
	Characteristics
Provinces	Shaanxi, Sichuan and Yunnan
Growing season	Two main types of corn: one is summer corn (seeding between end of May and end of June, harvest in mid Sept.); alternative is winter corn (seeding in Nov., harvest in Feb.)
Water supply	Rain fed. Precipitation: 800-1200 mm occurs mainly between Apr. and Oct.
Soils	Rather heterogeneous within the region
Rotation	In the cold mountainous area: one crop per year with two options: 1.Spring corn; 2.spring corn interplanted with potatoes In hilly & mountainous areas: two crops per year in two ways: 1. Corn following early spring crop (potatoes, peas, rapeseed and wheat) 2. Double corn in one year In the plains: two or three crops per year. Typical rotations: wheat-corn, wheat-corn-rice, catch crops-corn-rice and wheat-corn- sweet potato
Machinery	It is difficult to use machinery in the mountainous area. There are some small machines in hilly areas and the plains area. It should be easy to use large machinery in the plains area, but there are some ridges in a small sector of the farmland.

Sources: Yang, Z. etc., Maize in Northeast Region of China; Sun, Z., Zhao, J., Maize planting in 50 years; Li, S. etc., High yield and efficiency maize cultivation mode; Experts interviews.

5 Yields, acreage, farm structure and profitability of corn production in provinces of Corn Belt

In Table 2 a summary of some key statistical information about corn production in the Corn Belt provinces can be found. What is important to note is that shares of corn in arable land are very high in most of the provinces.

Yields tend to be low compared to other global corn producers such as the USA, especially when taking into account the relatively high precipitation rates in many regions (see respective figures in Table 1) and- compared to countries such as Argentina and Brazil- high fertilization rates.

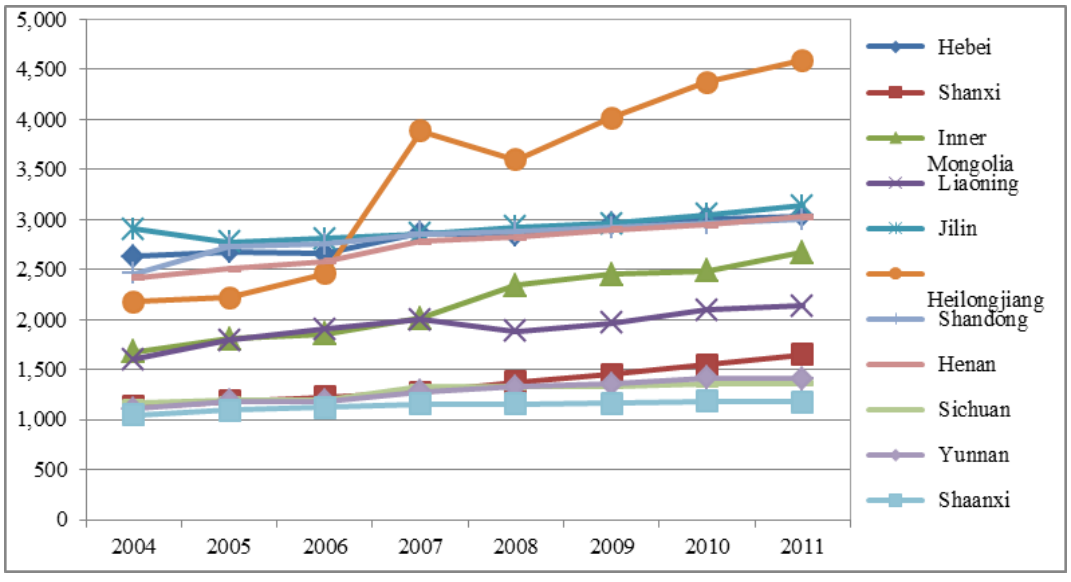
Table 2: Features corn production in Corn Belt provinces (2011)

	Provinces	Corn acreage (1,000 ha)	Total acreage[3] (1,000 ha)	Corn acreage /Total acreage	Corn production (1,000 t)	09-11 ø Yield (t/ha)
1	Heilongjiang	4,587	12,223	38%	26,758	5.3
2	Jilin	3,134	5,222	60%	23,390	6.7
3	Hebei	3,036	8,774	35%	16,396	5.1
4	Henan	3,025	14,259	21%	16,965	5.6
5	Shandong	2,996	10,865	28%	19,787	6.6
6	In. Mongolia	2,670	7,110	38%	16,321	5.8
7	Liaoning	2,135	4,146	52%	13,603	5.6
8	Shanxi	1,647	3,797	43%	8,546	4.9
9	Yunnan	1,409	6,668	21%	5,982	4.2
10	Sichuan	1,363	9,566	14%	7,016	5.0
11	Shaanxi	1,178	4,181	28%	5,507	4.6
	Sub-total	27,179	86,810	31%	160,271	5.4
	China-Total	33,542	162,283	21%	192,781	

Source: China Statistics Yearbook 2012

When looking at the **evolution of corn acreage** in the Corn Belt the situation as displayed in Figure 5 can be found: In these provinces acreage grew between 2004 and 2011. The strongest growth took place in Heilongjiang and Inner Mongolia.

Figure 5: Evolution corn acreage in Corn Belt provinces (2004 to 2011)



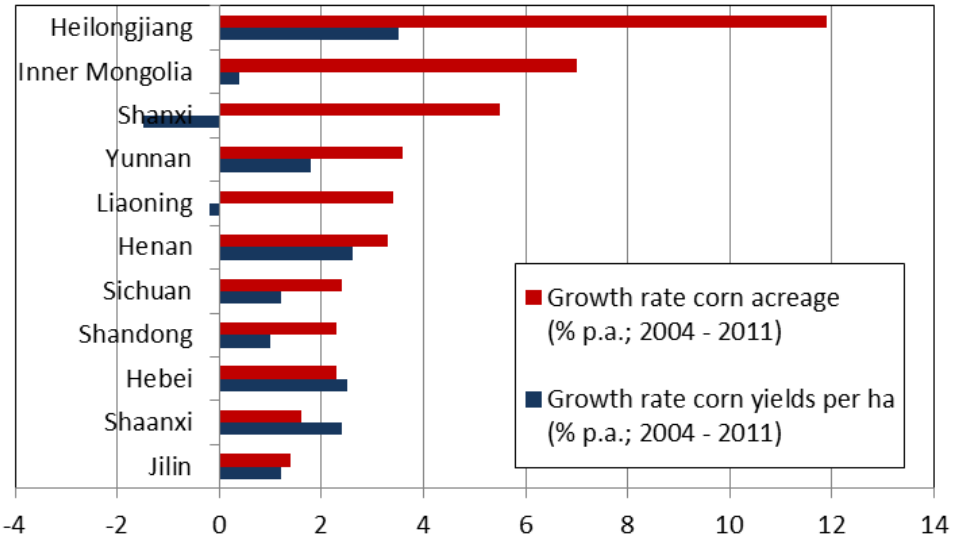
Source: China Statistics Yearbook 2012

[3] Total acreage includes rice, wheat, corn, beans, tubers, oilseeds, cotton, fiber crops, sugar crops, tobacco, vegetables, tea plantations and orchards.

Given the size and the share of corn in total arable land in these two leading provinces, the change can be considered a historical shift since a 7 or 12 % increase year on year is tremendous. Heilongjiang is especially remarkable because it has simultaneously achieved the strongest yield increase (3.7 % p.a.) as well (see Figure 6).

Shanxi is also a special case: Even though the yield trend was negative, corn acreage grew at a high speed (third highest growth rate in this comparison). Most likely the cause is that growers on poor farm land gave up wheat production and increased corn production. Due to higher yields in corn compared to wheat this move was economically attractive even though corn yields at those new sites is lower than in the previous corn producing regions of the Shanxi province.

Figure 6: Annual growth rates in corn acreage and corn yields

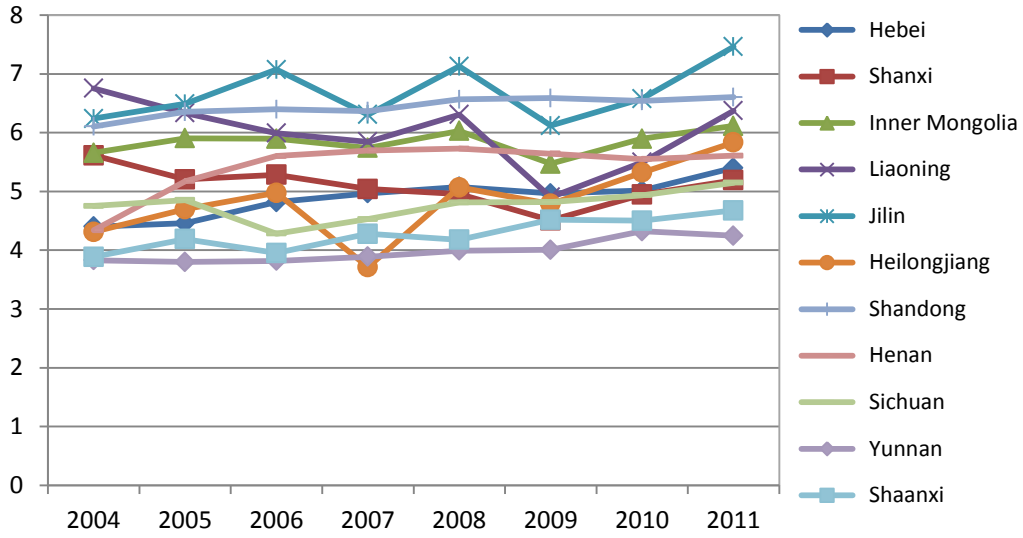


Sources: China Statistics Yearbook 2012; own calculations

Compared to the strong growth in acreage a different picture has to be painted as far as the **evolution of corn yields** is concerned (see Figure 6 and Figure 7). In fact, the increases in yields are rather modest – given the relatively low levels that corn started from.

Heilongjiang had the fastest growth in corn yield (+3.5 % p.a.). Overall, most provinces realized a modest annual growth rate of about 1 to 2 % (see Figure 6). Main exceptions are Inner Mongolia, Shanxi and Liaoning where increases were significantly lower or even negative. However, when comparing this development in yields to the national figures (0.9 % yield growth – see Figure 2) it appears that the Corn Belt provinces – even though they grew there corn acreage rather strongly – were also able to increase yields much more than others.

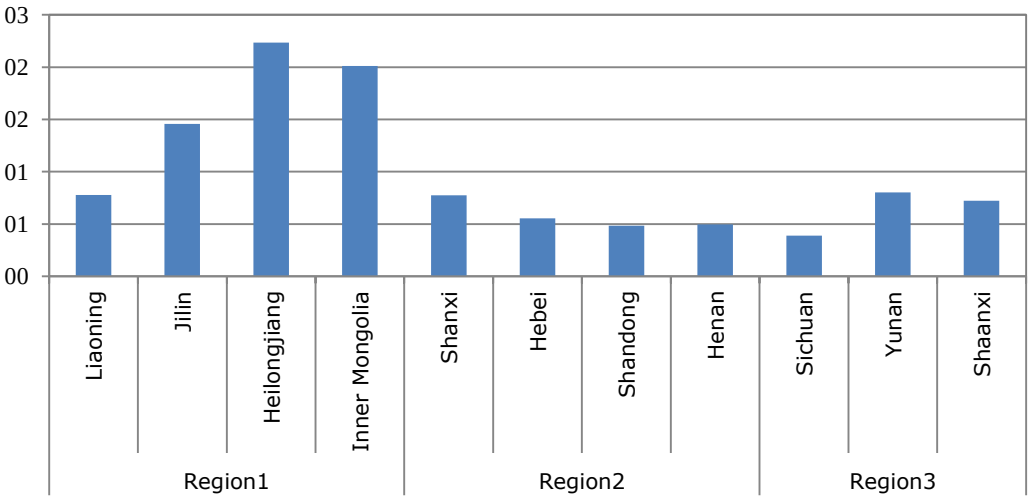
Figure 7: Evolution corn yields in Corn Belt provinces (t/ha; 2004 to 2011)



Source: China Statistics Yearbook 2012

Farm sizes vary throughout the three top corn producing regions. The average farm size of region 1 (Heilongjiang) is about 2.2 ha and thereby the highest of the three regions. However, one has to keep in mind that Heilongjiang is characterized by a large number of very large formerly state owned farms. This causes the average farm size to go up significantly.

Figure 8: Average farm sizes in Corn Belt provinces (ha)



Source: China Statistics Yearbook 2012

Without further study it is not clear whether or to what degree the typical smallholder farm in this region is significantly bigger than those in other provinces. Normally the average farm size in the Corn Belt is less than 1 hectare.

When looking at **profitability figures for corn production** in the Corn Belt (see Table 3) it seems that this crop was fairly profitable in all of the provinces, except for Yunnan[4]. The figures for revenue and profit refer only to market revenue; no statistical data is available for corn specific or general subsidies in different provinces.

Table 3: Economics of corn production in Corn Belt provinces (2011)

	Yield t/ha	Revenue (¥/ha)	Total cost (¥/ha)	Direct cost (¥/ha)	Fertilizer cost (¥/ha)	Labor cost (¥/ha)	Land cost (¥/ha)	Profit (¥/ha)
Hebei	5.4	12,091	7,538	3,218	1,681	2,727	1,594	4,553
Shanxi	5.2	11,879	6,886	2,752	1,766	3,198	936	4,994
In. Mongolia	6.1	13,227	8,841	3,868	1,862	2,725	2,248	4,387
Liaoning	6.4	14,213	10,582	4,348	2,244	3,336	2,898	3,631
Jilin	7.5	15,901	12,685	5,134	2,383	3,577	3,975	3,217
Heilongjiang	5.8	11,619	8,127	3,380	1,548	1,948	2,799	3,493
Shandong	6.6	14,892	9,511	4,641	2,480	3,320	1,550	5,381
Henan	5.6	11,934	8,346	3,180	1,825	3,228	1,937	3,589
Sichuan	5.2	11,845	9,546	3,232	1,529	5,314	1,001	2,300
Yunnan	4.3	9,662	11,785	3,999	2,139	6,544	1,242	-2,122
Shaanxi	4.7	10,123	8,851	3,713	1,868	4,308	830	1,272

Source: National Development and Reform Commission 2012

What is remarkable from looking at Table 3 is the fact that land cost tends to be higher in the Northern provinces compared to the central and southern provinces. The finding is somewhat contra intuitive because in the southern provinces cropping systems tend to be much more intensive: double cropping and even three crops in one year are grown here. And what is remarkable as well is the fact that even though corn production in Inner Mongolia is to a large extent based on irrigation systems the land rents are not the highest in this comparison – Heilongjiang as well as Jilin and Liaoning report higher land cost.

As far as intensity of fertilization is concerned there seems to be a differ-

[4] Why in particular in this province corn production was not profitable according to official figures is not clear. One element of explanation might be the fact that this region is rather hilly, hence little possibility to use machinery which in turn leads to high labor cost. A second factor is low yields – this region realized the lowest corn yields in the entire comparison. However, question marks remain.

entiation among provinces. But what is somewhat troublesome is the circumstance that figures on fertilizer expenditures are not very strongly correlated with yield levels: the correlation coefficient is only 0.54. Hence it seems that other factors than quantities of fertilizers applied – for example location relative to fertilizer factories and hence fertilizer prices – are more important for expenditures.

6 Selection of relevant provinces for establishing typical farms in China's Corn Belt

Based on the figures presented in this report the following considerations are deemed to be relevant for the selection of provinces in which typical corn producing farms should be established:

(1) Given the diversity of natural and agronomical conditions especially with regards to (a) precipitation/irrigation, (b) slope of the countryside and (c) typical cropping pattern [rotations; double cropping vs. mono cropping] it seems to be advisable to choose one province from **each of the three major regions** (upper, central and lower Corn Belt). The only concern one may have is the fact that in the lower Corn Belt yields are below average of the entire Corn Belt, corn share in total acreage is lower than in the other regions as well (app. 20 % vs. +30 % - see Table 1) and profits are clearly at the lower end too - or even negative in one province (see Table 3)

(2) Within the three main regions it is suggested to choose those provinces where the evolution of corn acreage was most dynamic – both in terms of growth of acreage and of yields.

(3) When following this suggestion in the upper part of the Corn Belt Heilongjiang would be the region to look at. As can be seen from Figure 6, this province experienced a significant increase in corn acreage of app. 7 % p.a. The only argument against this selection is the fact that this would exclude Inner Mongolia from the analysis. This is an issue because this region is one of the few in this comparison where corn production is predominantly based on irrigation.

(4) Regarding the central part of the Corn Belt the province Shanxi is the one with the strongest growth in acreage (app. 5.5 % p.a.). The only concern: yield dynamic was negative in the last decade (app. -1.5 % p.a. - see Figure 6). Therefore it appears to be better to establish the second typical farm in Henan, where acreage and yield increased by about 3 % p.a. Alternatively, Shandong would qualify as well with a growth rate for acreage of more than 2 % annually.

(5) When one intends to include the lower part of the Corn Belt where a very intensive cropping system with up to three crops per year is in place the province Yunnan looks rather promising (3.5 % p.a. growth in corn acreage). The only issue: this province shows the lowest absolute yield level during 2009 to 2011 (4.6 t/ha). Hence one may consider including Sichuan in the comparison where acreage went up by more than 2 % p.a. as well and yields are in the range of 5 t/ha with an annual growth rate of above 1 %.

(6) As far as structural differences at the farm level is concerned this proposal for provinces to go to would make sure that the larger farming systems in the Northern provinces would be included anyhow – be it in Heilongjiang or in Inner Mongolia.