A preliminary survey of cropping systems in Tibet

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Abstract

Authorities in the Tibet Autonomous Region of China are concerned about the sustainability and productivity of food production systems, and have initiated a number of projects that aim to?boost grain production. However, there is limited information available on current cropping systems, yields and likely yield constraints. To address this knowledge gap, structured interviews were undertaken in 45 farming households across Tibet's central cropping zone. Information was obtained on the crops grown, common farming practices and yields typically attained. Spring barley and winter wheat were found to be the predominant crops, followed by rapeseed, winter barley, and minor fodder and vegetable crops. Cropping systems were characterised by heavy tillage, high sowing rates, high rates of fertiliser application, some use of herbicides, little stubble retention and low levels of mechanisation. Most crops were irrigated, and yields of the main cereal crops were found to be about 4−4.5 t/ha. It is suggested that research and extension in the areas of crop variety, weed control, crop nutrition and seeding technology should lead to significant increases in grain yield. Research is also needed to improve understanding of socio-economic issues, and to improve animal fodder supply so that more crop residues can be retained after harvest.

Key Words

extant farming system, subsistence, agronomy, no-till

Introduction

Despite rapid economic growth in China over the past decade, economic conditions in western China remain poor, with hundreds of millions of people living on less than $US 2 per day and a large disparity between rural and urban incomes (World Bank, 2005). One of the poorest regions under Chinese jurisdiction is the Tibet Autonomous Region (henceforth, Tibet); Tibet ranks poorly in terms of per capita income, and a range of health and education indicators (Dreyer, 2003). Food security is considered to be low (Tashi et al., 2002).

Located in south-western China, Tibet encompasses vast tracts of mountainous terrain and the high altitude *Chang Tang* plateau, leading to an average elevation of over 4000 m a.s.l.. Most areas are unsuitable for permanent human settlement. Only the valleys of southern Tibet – in particular the valleys associated with the Yalongzangpo River and its two tributaries, the Nyachu River and the Lhasa River – have proven suitable for agriculture. The Yalongzangpo River valley runs mainly from west to east across southern Tibet, at elevations ranging from around 3900?m?a.s.l. in the west to 3500 m?a.s.l. in the east. The valley system encompasses about 230,000?ha of cropland and has been designated the 'crop-dominated production zone' of Tibet (Tashi et al., 2002). Climate is characterised by cold winters but warm summers, strong sunshine and a summer dominant rainfall of around 440 mm.

There are about 2.7 million permanent residents in Tibet, of which 2.2 million (80%) live in rural villages (TSY, 2007), mostly in the Yalongzangpo valley. Though large numbers of non-Tibetan migrants have moved to Tibet over the past 40 years, most settle in urban areas, and practically all rural dwellers are ethnic Tibetans (Goldstein et al., 2003; Fischer, 2006). Livelihoods are based around the production of grain crops and the raising of some livestock (predominantly cattle) on land issued to families after decollectivisation in the 1980s. Most agricultural produce is likely to be consumed on farms rather than sold, and most families supplement their incomes by sending family member(s) to work off farm (Fischer,

2006; Goldstein, 2008). However, cash incomes in rural areas are extremely low, at around 2000 yuan ($US 300) per capita per year (TSY, 2007).

Addressing poverty and reducing the gap between rural and urban incomes has been a major focus for the Chinese Central government for much of the past decade. Within Tibet, the government has set specific goals to boost grain production to improve food security and to raise rural incomes. However, few details have been published of Tibet's farming systems. The aim of the present study was to use structured interviews with farmers to provide baseline information on Tibet's cropping systems and help identify areas where research might lead to improvements in grain production.

Methods

Farmers for interview were selected to represent a range of ages and socio-economic status from different environments within the crop-dominated zone, from Shannan Prefecture in the east (29.15'N, 91.46'E, approx. elevation 3550 m a.s.l.) to Shigatse Prefecture in the west (29.15'N, 88.53'E, approx. elevation 3850 m a.s.l., Shigatse). Two teams of enumerators were used. Interviews were conducted in the Tibetan language with individual farmers alone or with their families, in either their fields or households. The same set of standardised questions was used for all interviews. Subjects explored included farm characteristics, mechanisation, crops grown, cropping inputs and practices, and yields obtained. Questions on crops grown referred specifically to the year 2006, whereas questions on crop husbandry and yields were more general so answers reflected typical farmer practice. Interviews were conducted in July and August 2006.

Results and Discussion

Interviews were conducted with farmers from 22 different villages spanning a majority of the crop-dominated zone, as defined by Tashi et al. (2002), and 45 interviews were able to be completed in the time available to the study. While less than ideal, this was the maximum number possible given language constraints, poorly developed farmer networks and other logistical issues. Quantitative data on the proportion of farmers growing each crop and areas sown are shown in Table 1. Table 2 shows basic data on agronomic practice and yields for the three most widely grown crops; *viz*., spring barley, winter wheat and rapeseed.

Crops grown

According to interviews, the most important crop grown in Tibet is barley (54% of the sown area; Table 1). The predominance of barley came as no surprise. Eaten as parched or roasted flour (*tsampa*), barley has provided the staple food for Tibetans for millennia (Tashi, 2005). While most barley grown is spring sown, small areas of winter barley are also grown. Winter barley was introduced to Tibet during the 1970s and 1980s, but has never been widely grown due to susceptibility to winter kill. The second most important crop in Tibet is wheat. Traditionally, the wheat grown in Tibet was of spring type, and it was only during the 1960s and 1970s that winter wheat varieties were introduced. These were initially heavily promoted by government, and continue to be grown on around 30% of the cropped area. Spring wheat appears to have disappeared from common use. The third most important crop grown in the crop-dominated zone is rapeseed (*Brassica rapa or B. napus*), grown by around half the farmers but only in small areas (7% of the sown area). Rapeseed is a traditional crop of Tibet used to provide cooking oil. The remaining minor crops grown, each sown to <5% of the cultivated area, are fodder crops (any of maize, vetch or oats), potatoes, field peas and miscellaneous vegetables (Table 1). Land area in Tibet is measured in *Mu*, a unit equivalent to one fifteenth of a hectare. The average area cropped by each farming household was 12.1 *Mu* (0.8 ha).

Yields

Yields for the three main crops were estimated by farmers to be 4.3 t/ha for spring barley, 4.5 t/ha for winter wheat and 1.8 t/ha for oilseeds (Table 2). These yields are well above the global average yields for

wheat (2.8 t/ha) and barley (2.5 t/ha), while yields of rapeseed are similar to the global average yield of 1.7 t/ha (FAO, 2008). However, it is likely that yields are significantly lower than could be possible with best practice agronomy. Evidence for this comes from the fact that well-managed research plots in Tibet regularly yield around 8?t/ha of winter wheat, 6 t/ha of spring barley, and 2.7 t/ha of rapeseed (PIRDP, 2005). In addition, near world record wheat yields have been reported in another area of the Tibetan Plateau, the Chaidamu Basin of Qinghai Province, where the environment appears similar (Sinclair and Bai, 1997). Tashi et al. (2002) agree that there is a large gap between attainable yields in Tibet and those that are typically attained on farms in the cropping zone.

Crop husbandry

Quantitative data from interviews (Table 2) as well as qualitative responses provided a general picture of current agronomic practice in Tibet. In brief, Tibetan farmers flood irrigate their fields in autumn for winter cereals, or spring for spring sown crops, before ploughing with a mould-board plough pulled by a small tractor (50% of cases) or a draught animal. Fields are then levelled either manually or by pulling a heavy plank of wood across fields, before seeding using small tractors and seed-drills or broadcast (rarely). Seeding rates are high, at 270 kg/ha for cereals and 24?kg/ha for rapeseed (Table 2). Sowing dates were described by most farmers as ‘early October’ for winter crops, and late March to April for spring crops. Fields are spread with manure before ploughing, though rates of manure application may have declined in recent years due to shortages in fuel-wood and the need to use manure as fuel for household fires. All farmers also use inorganic fertilisers, with urea applied at an average base rate of 270?kg/ha and di-ammoniumphosphate (DAP) at 225?kg/ha; most farmers then top-dress cereal crops with 75?kg/ha of urea. Weed control is achieved using a combination of cultivation, hand weeding, and in-crop application of broad-leaf or grass-selective herbicides. However, weeds appear to be a major problem in many crops. Fields are irrigated six to seven times across the year, depending on availability of water and rainfall. Practically all grain crops in Tibet are harvested by hand, with cut crops threshed in a village threshing area. Harvested straw is then used as fodder for cattle, which are typically kept tethered outside households. Some straw is also mixed with manure and burnt as household fuel. Harvest occurs in August for most crops, though may be slightly later in the western, higher reaches of the crop-dominated zone. Farmers typically utilise a rotation involving one or two years of spring barley followed by winter wheat, then any of barley, oilseed, field peas or potatoes and other vegetables. Practically all arable land is cropped each year.

Table 1. Cropping data from 45 farms in the crop-dominated zone of Tibet.

Crop	% That grow	Area/farm (*Mu*)	% Sown area
Spring barley	76	6.1	50
Winter wheat	76	3.8	31
Winter barley	13	0.5	4
Oilseed	51	0.8	7
Fodder	38	0.6	5
Potatoes	49	0.3	3

Field peas	4	<0.2	<2
Misc. vegetables	13	<0.2	<2
Area cropped (*Mu*)		12.1	

Table 2. Typical/average crop husbandry practices from 45 farms for the main crops grown.

	Winter wheat (n=34)	Spring barley (n=34)	Oilseed (n=23)
Yields (t/ha)	4.5	4.3	1.8
Seeding rate (kg/ha)	270	270	24
Sowing date	early Oct	Mar-Apr	Mar-Apr
Urea (base rate; kg/ha)	270	270	150
DAP (kg/ha)	225	225	150
No. of irrigations	7	5.7	5.7
Harvest date	Aug-Sept	Aug	Aug

Opportunities to boost grain production in Tibet

Based on insights from interviews, we suggest there are six main priorities for research to help close the gap between potential and actual grain yields in Tibet.

1. Crop varieties. The varieties grown of the main wheat, barley and rapeseed crops are both ancient and local or were bred more than 30 years ago. A search within the international germplasm for higher yielding varieties of these crops could lead to improved yields.

2. Weed control. Though farmers currently use a combination of hand-weeding and herbicides to control weeds, most crops observed were very weedy. There is a need to identify the most important weeds on Tibetan farms, the yield penalties they impose, and to develop and promote effective integrated weed management strategies. This need has also been identified by Hobbs (2006).

3. Crop nutrition. Though fertiliser rates appear high, current fertilising regimes focus exclusively on nitrogen and phosphorus nutrition. We believe other nutrients (*e.g.* potassium) may be deficient and that research is needed to test soils and plant nutrient status across Tibet, so that more specific fertiliser programs can be developed. Research should also be conducted to test organic matter content of Tibetan soils, and to see if increased retention of crop residues could improve soil health.

4. Tillage and crop establishment. Around the world, heavy tillage prior to sowing is increasingly being recognised as unnecessary and even detrimental to the environment and to farming systems (for review, see Hobbs 2007). Preliminary research at the Tibet Agricultural Research Institute has shown that no-till seeding can be adapted to Tibetan conditions, leading to more efficient crop establishment, more timely sowing and improved soil structure.

5. Fodder cropping. Assuming increased retention of crop residues would be beneficial to cropping systems, research into fodder production in Tibet is recommended, for example using cereal/fodder intercrops or double crops to reduce farmer reliance on cereal straw as fodder and improve animal nutrition.

6. Socio-economic research. It is acknowledged that no program to boost grain production is likely to succeed unless it aligns with the wants and needs of farmers. Further interviews and workshops are required to find out from farmers what their attitudes are to the intensification of grain production, and to investigate issues such as market access and the economics of increased grain and fodder production.

Conclusions

Interviews with 45 farmers across the crop-dominated zone of central Tibet revealed spring barley and winter wheat to be the major crops of Tibet, accounting for 81% of the sown area. Yields are high, relative to global averages, but are probably lower than should be possible with improved crop varieties, weed control and nutrition. Research should also be conducted to assess the feasibility of no-till cropping in Tibet and to adapt the technology to Tibetan conditions. To ensure research is relevant to farmers, and to maximise chances of successful extension, further information will also be required on farmer attitudes, motivation, and socio-economic barriers to adoption.

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