

Farming systems of the Loess Plateau, Gansu Province, China

Sharna Nolan ^a, Murray Unkovich ^{b,*}, Shen Yuying ^c, Li Lingling ^d, William Bellotti ^e

^a *School of Geography and Environmental Science, Monash University, Clayton, Vic. 3800, Australia*

^b *Soil and Land Systems, School of Earth and Environmental Sciences, University of Adelaide, Roseworthy, SA 5371, Australia*

^c *College of Pastoral Agricultural Science and Technology, Lanzhou University, Lanzhou 730020, China*

^d *Agronomy Faculty of Gansu Agricultural University, Lanzhou 730070, China*

^e *School of Agriculture, Food and Wine, University of Adelaide, Roseworthy, SA 5371, Australia*

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Abstract

Gansu Province in north western China contains a large portion of China's rural poor. Within this province we compared extant farming systems in lower and higher rainfall areas of the Loess Plateau. The farming systems were dominated by subsistence winter wheat production in the higher rainfall more productive area (Qingyang), and subsistence spring wheat in the lower rainfall less productive area (Dingxi). Once household grain production is satisfied, remaining land is allocated to cash crop and livestock enterprises. Similar farm sizes (ca. 1 ha) in both areas meant that farmers in the more productive Qingyang area were easily able to meet household food needs and produce more cash income from sale of produce. They have reinvested this into their farms and are now developing new enterprises, particularly livestock and co-operative trading arrangements. This has allowed many of these farmers to move away from subsistence grain production, such that 72% of household income is now derived from sale of farm produce. However, many farmers in Qingyang indicated a lack of technical agronomic support and limited access to reliable markets as barriers to diversification. In Dingxi, many farmers struggle to grow sufficient grain for household use and generate very little cash income, often insufficient to provide basic needs such as education. Potatoes, pea and oilseeds are the most common cash crops here, but livestock enterprises are poorly developed. In this area only 28% of household income is generated on farm, and young males often leave the farm to work in larger cities, leaving farming decisions to the elderly, women, and children, who are left behind to manage the farm. High illiteracy rates in this group reduce assimilation of new information. Farmers in Dingxi indicated that restricted access to capital, lack of technical agronomic support and little access to trading markets were serious impediments to the development of more profitable enterprises.

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1. Introduction

Despite China's booming economy, income disparity between rural and urban populations (effectively western and eastern provinces) is amongst the highest in the world (Chang, 2002). The bulk of the rural poor come from the north western provinces, where an estimated 53% of the Chinese rural population (totalling 900 million) live on less than US\$ 2 per day (World Bank, 2005). Gansu Province in north western China, is home to approximately 40% of

China's rural poor. Across the Province, household income averages only Y1946 (US\$ 243) per year, 70% of which is gained from agricultural activities with the remainder from wages earned off farm (MOA, 2001). A lack of land and capital resources, combined with high population densities has led to widening disparity between rural and urban incomes. This is particularly evident in one of Gansu's poorer counties, Dingxi, where the average per capita income for urban residents in 2002 (Y5015, US\$ 627) was more than triple the earnings of local rural populations (Y1412, US\$ 176 (Anon., 2004)).

Gansu Province sits on the Loess Plateau, a geographical feature located in the middle reaches of the Yellow River, the

* Corresponding author.

E-mail address: murray.unkovich@adelaide.edu.au (M. Unkovich).

plateau covers >400,000 km² over five provinces. Some parts of the region have been cultivated for 6000 years. Soil type, slope, rainfall patterns and cultivation mean that soil erosion here (3720 t km⁻² year⁻¹, rising to maxima of 20,000 t km⁻² year⁻¹ (Liu, 1999)) is the highest in China, and indeed amongst the highest in the world (Fu, 1989). Erosion is principally caused through run off during the rainy season (July–September), resulting in gully erosion and high sediment loads to the Yellow River. While erosion is reduced by perennial forest or grass cover, most of these areas have diminished due to increased subsistence arable agriculture and overgrazing (Rui et al., 2002). This has further eroded the natural resource base and resulted in low crop yields and low farm incomes over much of the region.

Addressing poverty and improving the environment across the Loess Plateau has become a priority of government policy. In Gansu, Provincial strategies aim to reduce farmer reliance on grain production, increase the production of cash crops and livestock and relocate farming villages to more fertile lands (MOA, 2001). Supporting this policy is a heavy investment in rural infrastructure and transport networks by government, and a recent revegetation campaign that encouraged farmers to replant slope land with forage legumes in exchange for grain (Feng et al., 2003). This policy has proved to be popular with most farmers while the grain and cash subsidies have reached the farmers, but as with all such policies, there are concerns over what will happen if and when this program has been withdrawn. Indeed in the study areas there is already evidence that farmers are reverting to previous cropping practices. While there is evidence of progress in some areas (Shi and Shao, 2000; Rui et al., 2002; Zhang et al., 2004), little is known about the way farmers in different agro-climatic zones are able to respond to government policy and market signals. Some regional statistics show that farmer incomes are improving, but it is difficult to gauge whether this is due to farmer innovation, improvement in commodity prices, off farm income sources or the success of government policies.

While erosive processes (e.g. Fu, 1989; Shi and Shao, 2000) and some aspects of crop agronomy (Li et al., 2000b; Huang et al., 2003) have been well studied, there has been little published on extant farming systems of the region. One study (Hardiman et al., 1990) in eastern Gansu's Qingyang County identified three different subsistence farming systems, based on landscape (slope), farm size and labour units household⁻¹. The most common farming system was located on productive tablelands, experiencing high grain yields, with livestock enterprises focussed on rabbit skin and wool production. Of the other two farming systems, one occupied sloping land, resulting in high erosion rates and poor grain yields and was therefore more focussed on livestock enterprises. The other occupied the small amounts of land within wide river valleys and consisted of a productive wheat–maize based system with no reports of other cropping enterprises.

The aim of the present study is to provide insight into extant farming systems and farmer opinions in two climatically contrasting environments in Gansu Province (Qingyang and Dingxi Counties), using a combination of available data, extensive farmer surveys and interviews in 125 households. We hypothesize that differences in farmer ability to change in response to government and market forces will be strongly moderated by local biophysical and socio-economic constraints.

2. Study area

2.1. Biophysical environment

The Loess Plateau is mostly 1000–1500 m in altitude, extending to >3000 m and consists of highly erodible hills, slopes and tablelands. Chinese farmers first began to build terraces in the region for crop production on sloping land more than 500 years ago, and while mechanisation has greatly increased the rate of terracing in the last 50 years, much is still done by hand (Zhengsan et al., 1981). Although the soils are deep, free draining and able to hold appreciable plant-available water (130 mm m⁻¹) for long periods of time (Zhu et al., 1983), a combination of low clay content and cultivation methods results in poor organic matter retention, structural instability (erosion) and low fertility for crop production (Catt, 2001).

Two localities, Qingyang County and Dingxi County, are chosen to represent the principal land systems and contrasting environments of the region. In biophysical terms, the areas differ in their position in the Loess landscape, with Qingyang (35.40°N, 107.51°E, elev. 1298 m a.s.l.) on tableland in eastern Gansu and Dingxi (36.03°N, long 103.53°E, elev. 1517 m a.s.l.) occupying Loess hills in central Gansu. Dingxi comprises of a number of small farming villages typically situated within narrow valleys that are surrounded by terraced mountains, where the majority of farmland is located. Soils are infertile sandy loams with a high silt content.

2.2. Climate

The region experiences cold dry winters and warm wet summers (Figs. 1 and 2), with annual rainfall ranging from 600 mm in the south east of the province to <100 mm in the north west (Li et al., 2000a). Rain falls sporadically over a short summer period but is highly variable from year to year with variability in monthly rainfall (CV) between years ranging from 45 to 100% for both Dingxi and Qingyang. The additional 155 mm of annual rainfall in Qingyang (551 mm) than in Dingxi (396 mm) provides the basis for greater fallow water storage (Li et al., 2000b) and much higher crop growth and grain yields than in Dingxi. In 2003, the year of our study, rainfall in Qingyang was 794 mm, more than double that of Dingxi (380 mm). Winter wheat (*Triticum*

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