

Article

Transforming the Peri-Urban Fringe in China: The Example of Xi'an-Xianyang

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Abstract: Rapid urbanization in the past four decades has transformed the hinterlands of China's major cities. While urban growth has consumed large quantities of farmland, many of the remaining farms in the country's peri-urban fringes have responded to the nearby presence of a fast-expanding and wealthier urban market by changing the farm enterprise to cater directly for this market. The various responses are exemplified herewith, for the metropolis of Xi'an-Xianyang (13 million population), in north-west China's Shaanxi Province. Based on participant observation and structured interviews with a sample of farmers from three peri-urban fringe villages, the study charted changes in ecosystem services as a quantitative measure of change between 1986 and 2017. An additional Delphi approach focused on the chief technological innovations during this period. The survey revealed the growing multi-functionality of those villages that had switched from traditional grain production to horticulture, supported by various government-funded programs. A significant development has been the introduction of farm-based tourism catering for urban-based tourists. The physical appearance of the fringe now resembles the so-called *desakota* landscape associated with south-east Asian cities, as massive new urban-industrial complexes sit alongside villages amidst islands of intensive farmland. The conclusion addresses key issues regarding the overall sustainability of agriculture within this fast-changing process of rapid urbanization.

Keywords: peri-urban fringe; China; ecosystem services; farm-based tourism; *desakota*; urbanization

1. Introduction

China's economy and society has been transformed since the wholesale economic reforms were introduced in 1978. Forty years of dramatic change have produced large-scale urbanization, fueled by substantial rural-urban migration. As a result, 0.8 billion (58%) of the country's current population live in cities. The huge scale of new urban development has consumed significant amounts of farmland around the growing cities, with vast new industrial and residential complexes being constructed to cater for the growing population. This has completely reshaped areas on the fringes of the cities (referred to here as the peri-urban fringe), producing complex land use patterns through the interweaving of industry, transport, retail, services, housing and farmland [1–4].

Local authorities have been keen to support new development on 'greenfield' sites as this has been an important source of municipal revenue [5], but this process raises important questions regarding the sustainability of these new urban-industrial complexes. There are different aspects to consider when addressing this issue with respect to the peri-urban fringe, including the amount of green space provided within the new developments and the nature of the evolving relationship between the growing cities and the remaining agricultural areas [6]. Around half of the urban expansion of the last

forty years has consumed arable land, so there are real concerns about the effects on food production and food security [7–9].

This paper examines this last issue—namely, the changing interaction between the growing city and its immediate hinterland in the peri-urban fringe, especially the changes occurring on the remaining farmland at the city's edge. The focus here is upon the survival of farmland in the fringe and its transformation under the influence of large-scale urban expansion and rural-urban migration. It is argued that whilst there have been certain China-specific characteristics that reflect the scale and pace of change, as well as the impact of policy interventions [10], there are also changes comparable with similar developments in the West. Hence, the specificities of the local situation have been tempered by the impacts of global phenomena. The paper illustrates this through a focus on a specific example, namely the Xi'an-Xianyang metropolitan area in Shaanxi province, west-central China (Figure 1). The investigation uses both quantitative and qualitative methods to consider changes to local village economies in the peri-urban fringe. It argues that the fringe has become multi-functional in character, reflecting the economic complexity brought about by forty years of modernization.



Figure 1. The study area.

1.1. Sustainable Urban Development: Relationships between Urban and Rural

Bithas and Christofakis [11] argue that urban sustainability can only be understood by considering the sustainability of the entire city region. In broad terms then, urban sustainability refers to the healthy biological functioning of the city region, both the urban and the rural parts. This implies that the relationship between the city proper and its rural hinterland is vital in determining the nature and extent of this sustainability. Traditionally, cities have drawn their principal resources (food, energy, water) from the surrounding countryside, with economic rent largely determining the resultant pattern of rural land use [12]. However, in most cases the combination of modern urban growth and the ability to source materials from around the globe has transformed this relationship, introducing new forces and actors, which have often contributed to loss of agricultural land to urban sprawl, as conceptualized by Robinson [13] (pp. 206–210). So, any given city, even with a productive rural hinterland, can no longer be said to be environmentally sustainable as an individual, self-contained system. In addition, cities increasingly ‘export’ negative externalities to the countryside in the form of pollution, waste and consumption of non-renewable resources, to which traditional economic–environmental policies have applied sophisticated instruments to neutralize the worst effects [14]. By removing people from the countryside, rural–urban migration may further harm rural productive potential and hence reduce sustainability. This potential can be assessed as part of broader agricultural sustainability assessments [15] that take into account multidimensional economic, environmental and social criteria [16] (pp. 106–139). Such assessments can be linked to the use of ecosystem services, described below, to measure the impacts of changing land uses [17].

Globalization has turned the city region, with its rural hinterland (or the ‘city beyond the city’ as it has been described [18], from being an ‘island of isolation’ into what Baycan et al. [19] (p. 293) term an ‘open network constellation’, impacted by global forces, which have reduced self-sufficiency and can negatively impact on environmental and social aspects of sustainability. Yet, local human factors, interacting with global forces, can bring about local innovation contributing to sustainable economic development by assimilating externally generated innovation. This is supported in the findings of Nijkamp et al. [20] who stress the importance of human capital, research and innovation as drivers of development in the city region, especially as part of endogenous growth: A blend of microeconomics and macroeconomic growth theory, in which smart use of local resources of a region (including people) plays a critical role [21].

In 21st century China, the city’s rural hinterland and its peri-urban fringe continue a transformation begun in the last quarter of the previous century. A key element in this process has been the reconfiguration of rural–urban linkages, leading to the fringe and the wider rural hinterland developing multifunctional characteristics. For example, farms have become more than just the producers of food and fiber; they now fulfil other functions, such as providing outlets for tourism and recreation, manufacturing and service activities. They supply labor to other proximate sectors of the economy in a blurring of urban and rural that has made the city region a more cohesive and sustainable entity in some respects despite the global forces helping to shape the nature of new urban–industrial complexes spilling out from the city into the surrounding countryside. Hence, urban–rural relations are being reshaped and recast, making the assessment of the overall sustainability of the new arrangements harder to determine. It is the multifunctionality and the nature of the new landscapes of the rural–urban fringe that are tackled below for one particular city region.

1.2. Agriculture in the Peri-Urban Fringe of Xi’an-Xianyang

Agriculture within the hinterland of China’s major cities has experienced two key drivers of change. One has been the need to move away from traditional farming systems that have struggled to meet the rapidly escalating demands to produce food and fibre for the growing population numbers [22,23]. The second is the response to having a rapidly growing urban market in close proximity. The latter has brought not only new market opportunities, but also competition for land and labor, with much farmland being lost to urban development, and massive rural–urban

migration making it hard to maintain viable rural communities [24]. Nationally, there has been a loss of nine million ha farmland since 1995, or >400,000 ha per annum (0.68% overall loss from 1984–2012 compared with 0.85% for ‘green’ or ‘ecological’ land), with a corresponding increase in urbanisation (+1.53%) [25,26]. Nevertheless, for many of the remaining villages in peri-urban fringes, through the increased influences of the fast-expanding domestic market and national policy guidelines/support, traditional farming activities have been transformed into more intensive and market-oriented modern agriculture [27]. In general, there has been substitution of capital for labor, with greater reliance on mechanization, purchased inputs and a more complex set of linkages between upstream (inputs to the farm) and downstream (outputs from the farm going to processing and sales) activities [6].

This transformation has had major impacts on the structure and function of the agri-ecosystem, resulting in a series of changes to the ecosystem services (ESS) produced by farming. These services refer to the benefits people derive from natural and managed ecosystems, whereby the ecosystem directly or indirectly provides production, necessities and services, including clean air, water, food and fuel. There are usually four categories of ESS recognized: Provisioning (e.g., food production), supporting (e.g., nutrient cycles), regulating (e.g., controlling disease) and cultural (e.g., recreation) [28]. All four may be affected by changes in agricultural production, and hence ESS have attracted much academic attention, especially within human geography, ecological economics and related disciplines [29–31]. There have been several studies of ESS in China, prompted by the scale of change and the range of both positive and negative changes created [32–34]. Most of this research has been conducted at the macro- and meso-scale, thereby largely ignoring detailed impacts of agricultural transformation on ESS at the micro-scale. Hence, many of the interpretations of changes in ESS are quite ‘broad brush’, lacking detailed interpretation, description and analysis of agricultural transformation.

This paper seeks to redress this balance in the context of the increasingly multifunctional agricultural development that is emerging on the Guanzhong Plain in the hinterland of Xi’an, the capital of Shaanxi province in west-central China, a city with a population of nearly seven million (compared with around one million in 1980), and the city of Xianyang, c30 km to the west, with a population of one million. Together the combined metropolis of Xi’an-Xianyang has a population of 13 million, many of whom live in new developments in the immediate hinterland of the two cities. The paper examines in detail changes occurring in three study villages near the metropolis (Duling, He, and Majia) between 1985 and 2017 (Figure 1). It addresses the contrasting responses made by these farming communities to the challenges that have presented themselves over this period, and the changes to the landscape across the peri-urban fringe.

The three villages were selected purposively, because they each represent one of the three main types of change occurring to the remaining villages in the fringe (others having been swallowed by urban sprawl). The presence of a massive and growing market close to the productive agricultural area on the Guanzhong Plain has been keenly felt by the farming communities in the fringe. It has presented opportunities for moves away from the traditional farming systems, which were dominated by grain production using methods little changed over a long period. Wholesale adoption of horticultural production to supply fruit and vegetables to the metropolis has occurred, but in a process of horizontal integration in which different villages have specialised in different crops. In effect there have been some grain to fruit, and some grain to vegetables transitions whilst a few villages remain predominantly grain producers.

The selected villages illustrate this horizontal integration in the various adoptions of new crops and systems of production, which have often reflected individual initiatives by farmers. There has been a Thünian response [35,36], in which the villages closest to Xi’an-Xianyang have been more influenced by modernization, innovation and large-scale changes to farming systems than those further away. For the latter, retention of poor transport links to the metropolis has restricted opportunities to sell fresh fruit and vegetables regularly in the urban market and hence the greater reliance on grain as the major source of income [37]. For example, of the three study villages, Majia, at 68 km (population 700) from central Xi’an, compared with Duling (17 km, population 770) and He (37 km, population c2000),

remains largely dependent on wheat production though modern machinery has been adopted over the past decade in response to government encouraging increased output through subsidies (at 60 yuan per mu in 2017 or US\$2.25 per ha) as part of food security planning. Meanwhile, Duling has adopted cherries, grapes and walnut growing whilst He now produces vegetables. Grain production has disappeared from both villages.

To date Majia has been by-passed by tourist development whereas it is greatly in evidence in Duling and it is taking off in He village. Across much of the fringe, tourism is a rapidly emerging phenomenon, with farmers in several villages obtaining additional income from pick-your-own schemes and farmhouse-based restaurants and cafes. The latter are part of the Farmhouse Joy (*nongjiale*) Movement [38–40]. Government support for agri- and rural tourism is indicated by the state-funded tourist village at Bailucang, near Duling, aimed at providing a ‘rural experience’ to day-visitors from Xi’an.

2. Materials and Methods

Both quantitative and qualitative methods were employed. The quantitative applied to analysis of the changing values of ESS between 1985 and 2016. The starting point in 1985 was chosen as at that time none of the three study villages had begun the move away from grain production and all three farmed using traditional methods. Surveys of the three study villages were performed, with numerical data collected from local farmers, which were then used to calculate the value of different services. Semi-structured interviews with the farmers and participatory mapping of land use focused on the nature of changes made to production systems over the 32-year period, especially the adoption of new crops and moves to diversify the farm economy. Exploration of the latter enabled the interviews to address the emergence of additional sources of income for farm families, including from off-farm employment and tourist-related enterprises. In addition, we focused on technological innovation, sampling 30 farmers in each village and ten ‘experts as a Delphi group, then employing an analytical hierarchy method to determine the most important innovations [41].

When calculating the value of ESS, a standard evaluation method was employed as set out in Song et al. [42]. This involved calculating changes relating to environmental health, atmospheric regulation, climate regulation, leisure and tourism, and the agricultural production function. The focus here was on how the agricultural and economic transformation had affected land use, focusing on three key aspects: Changes to the agricultural structure, impacts of the adoption of modern agricultural science/technology, and farmers’ behavior (especially decisions involving a move from the traditional to the modern). Across the three villages, a series of 130 structured interviews were conducted with farmers at different seasons in 2016 and 2017 to ensure that seasonal variations were observed. The authors’ own personal observations also formed part of the data gathering. GIS methods were used to map changes in detail between 1985 and 2017. Additional data were obtained from statistical yearbooks for both Xi’an and Xianyang for 1985 and 2017.

The three study villages were selected purposively. In both Duling and He land previously supporting grain crops is now under horticulture: For fruit in Duling, and vegetables in He village. In contrast, in Majia grain production still dominates, though some formerly productive land has been abandoned or converted to woodland. There has been a slight rationalization of land allocated to housing (construction land) in both Duling and He. In Duling a small block of land has been expropriated by government for tourist development.

3. Discussion/Results

3.1. Changes to Ecosystem Services

The three villages represented very different trajectories in terms of changing patterns of land use. Two (Duling and He) were part of the dramatic transformation to the economy in the peri-urban fringe whilst the other (Majia), in effect, was simply not part of the urbanizing and dynamically changing fringe. It can be said to have remained outside the immediate sphere of urban influence,

retaining its focus on grain production. However, it was responding directly to the country's economic revolution, as its population was dwindling rapidly through out-migration, and greater mechanization of its agriculture was also evident. Meanwhile, Duling was one of those villages experiencing a transition from grain to fruit production while He experienced a move from grain to vegetables. The rapidity of the move away from grains in Duling and He, largely taking place in the 1990s, also reflects the comparative advantage that these well-populated villages have had regarding the production of labor-intensive crops, such as fruit and vegetables, compared with land-intensive crops, such as grains and oilseeds.

These developments for Duling and He meant that the overall value of their ESS rose whereas for Majia the opposite occurred (−82.6%), though for all three the agricultural production functions comprised the largest proportion of the total ESS value. In He, modernization meant wholesale change from grain production to vegetable growing, principally tomatoes, celery and cucumbers, transported fresh for sale in Xi'an. Although land consolidation around 2000 had reduced the agricultural area in the village by 8.5 ha, the switch to vegetables produced a near fourfold increase in the production function (Table 1). He village illustrates intensification of production with the cultivation of vegetable under a crop rotation that enables two harvests per annum. Celery is planted and harvested first, after which tomatoes and cucumbers are planted. A doubling of the production function occurred in Duling, but associated with a move from grain to fruit, namely cherries and grapes plus some walnuts. The contrast with Majia is stark, where grain production still dominates and some land abandonment and conversion to forest has occurred (Table 2). Inflation has contributed to a decline in the real value of grain prices, further lowering the production function. Another contributing factor is that the loss of labor, concerns over hygiene and availability of cheap meat has meant that pigs are no longer being kept as an additional source of income. Yet, with support from government subsidies, Majia has adopted modern farm machinery for planting and harvesting wheat.

Table 1. Changes in the values of agri-ecosystem services.

| (a) Duling Village | | | |
|---------------------------|-------------|-------------|--------------------|
| ESV (10,000 Yuan) | 1985 | 2016 | Change Rate |
| Production function | 306.6 | 620.8 | 1.02 |
| Environmental health | 1.3 | 8.3 | 5.38 |
| Atmospheric regulation | 19.7 | 19.6 | −0.05 |
| Climate regulation | 8.4 | 14.0 | 0.67 |
| Leisure and tourism | 0.1 | 5.1 | 50.00 |
| Total | 336.2 | 667.9 | 0.99 |
| (b) He Village | | | |
| ESV (10,000 Yuan) | 1985 | 2016 | Change Rate |
| Production function | 877.6 | 4181.4 | 3.76 |
| Environmental health | 3.8 | 31.6 | 7.32 |
| Atmospheric regulation | 57.4 | 107.5 | 0.87 |
| Climate regulation | 24.4 | 77.3 | 2.17 |
| Leisure and tourism | 0.14 | 20.0 | 137.67 |
| Total | 963.3 | 4417.8 | 3.59 |
| (c) Majia Village | | | |
| ESV (10,000 Yuan) | 1985 | 2016 | Change Rate |
| Production function | 372.6 | 64.8 | −82.6% |
| Environmental health | 1.6 | 1.9 | 0.19 |
| Atmospheric regulation | 24.4 | 20.5 | −15.8% |
| Climate regulation | 10.3 | 10.5 | 0.4 |
| Leisure and tourism | 0.06 | 0.13 | 1.2 |
| Total | 408.9 | 97.8 | −76.1% |

Source: Authors' survey.

Table 2. Changes in land-use and ecosystem service values (ESV) changes in the study villages, 1985–2017.

| (a) Duling Village (Grain-Fruit Transition) | | | | | | | |
|---|-----------------------|-------------------------|--------------------|-------------------------|------------------------------|---------------------------------------|--------|
| Land Use | 1985 | | 2017 | | Change of Area ha | Change of ESV/ 10,000 Yuan | |
| | Area ha | Proportion % | Area ha | Proportion % | | | |
| Arable land | 62.4 | 84.24 | 0.3 | 0.45 | −62.03 | −86.12 | |
| Vegetables | 0.1 | 0.12 | 0.1 | 0.12 | 0 | 0 | |
| Orchards | Cherries in fruit | 0 | 0 | 26.4 | 35.59 | 26.35 | 419.39 |
| | Cherries not in fruit | 0 | 0 | 15.9 | 21.44 | 15.87 | 6.83 |
| | Grapes in fruit | 0 | 0 | 14.9 | 20.09 | 14.87 | 236.67 |
| | Grapes not in fruit | 0 | 0 | 3.2 | 4.28 | 3.17 | 1.66 |
| | Walnuts | 0 | 0 | 0.7 | 0.97 | 0.72 | 2.81 |
| Expropriated land | 0 | 0 | 1.8 | 2.36 | 1.75 | 0 | |
| Construction land | 11.6 | 15.64 | 10.9 | 14.70 | 0.70 | 0 | |
| TOTAL | 74.1 | 100.0 | 74.2 | 100.0 | 0 | 581.234 | |
| (b) He Village (Grain-Vegetables Transition) | | | | | | | |
| Land Use | 1985 | | 2017 | | Change of Area ha | Change of ESV/ 10,000 Yuan | |
| | Area ha | Proportion % | Area Ha | Proportion % | | | |
| Arable land | 180.6 | 75.6 | 0 | 0 | −180.6 | −963.3 | |
| Vegetables | Celery * | 0 | 0 | 189.0 | 79.2 | 189.0 | 1299.4 |
| | Tomato * | 0 | 0 | 94.5 | 0 | 94.5 | 1358.4 |
| | Cucumber * | 0 | 0 | 94.5 | 0 | 94.5 | 1760.0 |
| Construction land | 58.2 | 24.4 | 49.8 | 20.8 | −8.4 | 0 | |
| TOTAL | 238.8 | 100.0 | 238.771 | 100.000 | 0 | 3454.5 | |
| (c) Majia Village (No Transition) | | | | | | | |
| Land use | 1985 | | 2017 | | Change of Area ha | Change of ESV/ 10,000 Yuan | |
| | Area ha | Proportion % | Area Ha | Proportion % | | | |
| Arable land | 76.66 | 86.24 | 70.23 | 79 | −6.43 | −314.61 | |
| Trees | 0 | 0 | 0.49 | 0.55 | 0.49 | 1.47 | |
| Unused land | 0 | 0 | 5.94 | 6.69 | 5.94 | 2.15 | |
| Construction land | 12.23 | 13.76 | 12.23 | 13.76 | 0 | 0 | |
| TOTAL | 88.89 | 100.0 | 88.89 | 100.00 | 0 | −310.99 | |

* Crop rotation in this village enables two harvests per annum. Farmers cultivate celery first and then tomato and cucumber later in the year. So, in the table the area for celery is the same as that for the combination of tomatoes and cucumbers. Source: Authors' survey.

Use of pesticides, herbicides, and oil-based fertilizers, combined with increased mechanisation, has contributed to positive changes in atmospheric regulation, environmental health and other ecological functions, climate regulation, and indirectly the tourism function. In part, this reflects a shift in government policy: From increasing output of food grains (through minimum price supports on wheat and rice, and subsidies for mechanization) to support for rural incomes, and more recently, to addressing environmental concerns [43]. Options are being explored for more farm insurance, e.g., loss protection insurance and income-based insurance programs for grain producers [44].

The influence of farmers' behaviors on ESS has been complex. In both He and Duling, the focus on adopting new crops and then increasing output to maintain and improve incomes has substantially increased the value of production functions. Output has also been increased by use of biological pesticides (notably Thimet (formerly known as experimental insecticide 3911) and Dichlorvos (or 2,2-dichlorovinyl dimethyl phosphate)) under strict regulation, drilling new wells to increase the amount of irrigation, building greenhouses (in He), and improved management of farm wastes. Certain new aspects of farm management have also contributed to increases in the production function, e.g., in Duling the use of bags to protect grapes and establishing fences between plots; in He use of plastic film to protect young vegetable crops.

3.2. Government Support

All three villages have been able to take advantage of a plethora of different government-funded projects developed across the last three decades. As suggested in Table 3, most of the support has been applied to specific sectors and has been designed to translate research and development into innovation at the farm level. Thus, improved agricultural technology has been integral to the agricultural transformation, and has directly contributed to raising farm incomes. It has also been part of a direct substitution of capital for labor in Majia, where there has been an outflow of population to the growing cities. Majia therefore belongs to the large number of villages across rural China where out-migration has contributed to the phenomenon of 'hollowed villages' [45]. This refers to the neglect and ultimate abandonment of rural dwellings as the population in the working age groups leave to seek employment elsewhere. The elderly and the very young are often left behind, but the farmland can also become under-utilized and abandoned [46]. Strictly speaking, use of the word 'hollow' refers to villages where old houses and farm buildings in the center of the village are abandoned whilst new houses are being built on the edge of the village [47], but the term has been widely applied to all villages experiencing sharp out-migration.

All three villages have experienced some out-migration, but both He and Duling are also supplying daily commuters to work both in Xi'an itself and in the newly developed industrial and service sector developments in the fringe. He village has actually added new employment as jobs have been created in greenhouses and in preparing vegetables for market. In contrast, the continued reduction in labor used on the land in Majia is producing depopulation and abandoned houses in the village.

Changes in government legislation have been crucial to the modernization of agriculture in the peri-urban fringe. One of the key changes creating conditions conducive to rewarding individual initiative has been the evolution of the household responsibility system, from a collective or village responsibility to an individual basis in which individual households can make decisions about the land they farm [48]. While, in general, rural collectives own agricultural land, the granting of individual use rights to land in the 1990s as part of the process of de-collectivization has enabled individual farm households to have greater scope to innovate and raise capital for investment, so they can also sell their produce privately, which has provided more incentive to invest in the land and to adopt new technologies and new enterprises. In addition, relaxations of restrictions on the private retail sector and abolition of market centralization for food items in China in 1993 enabled fruit and vegetable producers to take advantage of the popularity of open-air retail markets for food in Xi'an-Xianyang [49].

Table 3. Government-funded projects supported in the study villages.

| |
|--|
| (a) Duling |
| Special project for comprehensive agricultural development |
| Horticultural breeding and production demonstration base project |
| Cherry Sanyou integration |
| Standard orchard creation |
| Boutique demonstration park |
| Science and technology training program |
| Grape root nodule resistant rootstock selection and promotion |
| (b) He |
| Vegetable basket product production |
| Seed engineering plant protection |
| Organic fertilizer application demonstration |
| A county-specific characteristic industry development pilot project |
| Planting modern agricultural demonstration zone |
| (c) Majia |
| Grain direct subsidy |
| Water-saving supporting project for medium-sized irrigation district in modern agricultural park |
| Agricultural machinery purchase subsidy |
| Cultivated land protection and quality improvement |
| Special agricultural development |

Source: Authors' survey.

The dynamic mechanisms of the agricultural transformation in the three villages have basically been the same, driven by the mutual influences of market logic and state intervention. Through the support and guidance of various policies and projects, government has actively promoted the move from traditional agriculture (using relatively simple technology) to intensive, modern market-oriented agriculture, which has had significant impacts on ecological and production functions. For example, government subsidizes seed in He and 'ecologically-friendly' pesticides in He and Duling. Improved agricultural technology has been integral to the agricultural transformation and has raised the incomes of farmers, especially in He and Duling where the fruit and vegetable crops allied to some farm-based tourism provide a contrast with Majia.

In terms of grain production, changes in government policy have also had a significant impact, with price subsidies reduced in the 1990s, incentives offered for growing improved varieties and adopting modern machinery, and deregulation of grain marketing. These measures have stimulated increased production from the early 2000s, especially after rural tax reforms in 2002/3 [10]. This can be seen in Majia, where grain yield has risen on terms of output per unit of labor. However, as out-migration has removed many of the productive workers from the village, there is less land under cultivation and overall there has been a sharp fall in the production function. The extent of the decline has also been magnified by falling grain prices.

A recent survey of water usage by farmers across the Guanzhong Plain revealed that 83% used some form of water-saving technique, but that most irrigation was still the wasteful 'border and furrow' method rather than more advanced, efficient methods, such as drip irrigation and underground pipelines [50]. Farmers in He village had tried the drip irrigation system when they introduced vegetable production, but their lack of knowledge of this technology contributed to its subsequent rejection and a return to using piped water from underground. The latter has been encouraged by government, via a start-up fund, as it is deemed a more efficient use of water than traditional irrigation methods. Hence, all three study villages had invested in underground pipes and/or channels to fields. For Duling, the village community purchases water from a local water company, but some farmers use local wells for their supply. The latter was also the case in both He and Majia. However, the small size of plots and, in some cases their fragmentation, also reduces efficiency of

irrigation and raises costs [51]. In Duling some fragmentation has been beneficial, helping farmers to adopt different crops, as plots with physical characteristics suitable for grapes may not be so suitable for cherries or walnuts and vice-versa.

3.3. New Technology

To further understand the role of new technology in transforming the agricultural economies of the three villages, we employed a simple analytic hierarchy process (AHP) with thirty farmers in each village and a group of ten ‘experts’ (a Delphi group). The farmers were asked to identify what they regarded as the most important technological advances affecting agriculture in their village in the last forty years. This was consolidated into a list that recorded the rank order by frequency of occurrence for the nine categories the farmers had selected. The list was then presented to the experts, who were drawn primarily from different disciplines (including environmental management, agricultural science and geography) in higher education in Xi’an, but including one overseas academic, and a couple of representatives from government departments. The experts each ranked the nine categories provided based on their view as to which was most important in promoting agricultural transformation in the villages. The weights for each category were generated using AHP, standardizing the weighting so that the outcome, as shown in Table 4, summed to 100.

Table 4. Combined farmer ¹ and Delphi group ² weightings of technological innovation in agriculture in the study villages.

| Innovation | Weight ($\Sigma = 100$) |
|---|---------------------------|
| New crops/new crop varieties | 26 |
| Online marketing/sales | 8 |
| Agricultural machinery | 3 |
| Controlled environments/Facility agriculture | 18 |
| Irrigation | 9 |
| Communications media | 2 |
| Direct link from innovation to increased output | 3 |
| Plastics for crop protection | 5 |
| Biological (organic) pesticides | 25 |
| Total | 100 |

¹ Number of farmers sampled = 30 per village, $\Sigma = 30$. ² Number of experts consulted = 10. Source: Authors’ survey.

Three categories dominate, accounting for just over two-thirds of the summed weights, namely the use of new crops/new crop varieties, organic pesticides and the use of controlled environments (e.g., greenhouses). New crop varieties (including new varieties of grain, as well as fruit and vegetables) symbolize the transformation of land use, but also denote an association with higher economic value or, according to many farmers and the Delphi group, the very survival of farming. Farmers regarded the use of biological (organic) pesticides as greatly reducing the damage done by oil-based chemical inputs to the soil and the general environment. They associated its use with sustainable development and environmental health. The adoption and greater use of controlled environments, such as glasshouses, were widely viewed by farmers as symbolizing modernity. Of the remaining six categories, two can be highlighted—namely irrigation and online sales, as these also symbolize a changing technological input to farming. Because online sales are not restricted by geography, possess no intermediate link (to middlemen) and low transaction costs, they are increasingly welcomed by the farmers. The increase in the proportion of networked online sales has helped stimulate increased output, a hallmark of agricultural modernization. In contrast, while irrigation is vital to farming in the villages, water is often still supplied by traditional means, which partly explains why the weighting for irrigation is not higher.

3.4. Tourism

A major feature of changes to ESS for Duling, and to a lesser extent He, has been the growth of the tourism and recreation function: The largest increases in the value of the various ESS in the three villages (see Table 1). This reflects the growth of a new income source for farmers as a direct by-product of the move to replace grain growing with fruit and vegetables. Each weekend in May and June, 60,000 visitors mainly from Xi'an-Xianyang flock to Cherry Grove in White Deer Plain near Duling where they can not only purchase fresh cherries direct from farms, but also go to farms offering a pick-your-own experience. Some have opened farmhouse restaurants and cafes and are part of the Farmhouse Joy (FMJ) movement [52].

The FJM “emerged as guesthouses selling nostalgic rustic or ethnic minority foods and back to basics dining in suburbs of big cities (. . .) and then broadened into taking lodgings in farm guesthouses run by peasant families” [53] (p. 197). It has ‘boomed’ in recent years “not only as a new style of holiday making among the Chinese urban middle-class, but also as a new form of private enterprise among millions of Chinese peasants” [54] (p. 520). It was initially associated with foodstuffs of ethnic majority Han Chinese farmers near major cities, but it has been spread via development projects and local initiatives, to emerge in ethnic minority villages. The restaurants have been marketed as an opportunity for urban residents to consume ‘farmers’ foods’ (*nongjiacai*) as an ‘authentic’ rural experience. So, urban residents are offered an opportunity for a brief return to the traditional rural roots of Chinese society as they experience an aspect of farm life in situ on or close to a working farm. This nostalgic view of rurality contrasts with the widely held view of many Chinese urbanites that rurality is associated with hardship, deprivation and a lack of choice [55,56] ([39], p. 159).

Further strengthening tourist development in the area, a government-funded ‘tourist village’ (named Bailuyuan-Bailucang scenic area) covering 140ha with a total investment of one billion yuans (US\$158 million) [57] has been opened near Duling as part of China’s Western Development Strategy (WDS) program in the thirteenth five-year plan of the China National Development and Reform Commission. The Guanzhong Plain is seen as a strategic area for the WDS. According to local officials, this tourism initiative aims to provide “an authentic rural experience” to day-visitors from Xi’an. During the three-day ‘May Day’ holiday in 2017, the scenic area received 1.02 million tourists [58]. Attractions include local folk culture, hot-air balloon carnival, a music forum, sports experience camp and LightScribe concert. The folk culture experience is based on the famous writer Chen Zhongshi’s literary masterpiece ‘Bai Luyuan’ (White Deer Plain, and hence the name of the scenic area and its locale) and has 423 folk buildings, built by professional craftsmen according to traditional construction methods. So, this is a recreated historic ‘village’, with shopping outlets, entertainment and opportunities to consume local produce [59], thereby acting as a new outlet for nearby farmers. The tourist village is located along the Silk Road under the One Belt One Road initiative [26] and is an example of several recent major Chinese investments in tourism mega-projects [60] (p. 651).

In 1997 Chen Zhongshi (1942–2016) received the Mao Dun Literature Award for ‘Bai Luyuan’ (published in 1993), the highest such award in China. This acknowledged how his book had captured the dramatic changes affecting China’s countryside over the last century. Zhongshi himself had spent decades in Xi’an’s rural hinterland, so his book captures an essential essence of the transforming rural China, based specifically on observations made of one hundred villages in twenty counties across the Guanzhong Plain. Knowledge of the book and its growing popularity was increased by the release of a film (of the same name) written and directed by Wang Quan’an, adapted from the novel, which won the Silver Bear at the 62nd Berlin film festival in 2012. In 2016 it was made into an opera, debuting in Xi’an, sung in local dialect and using traditional Chinese musical instruments. In addition, in 2017 it was turned into a Chinese television series, also of the same name, with 76 episodes. It won the best TV show award at the 24th Shanghai Film Festival and received the Outstanding TV Series Golden Angel Award at the 2017 Chinese American Film Festival.

All the attention fostered by the book and its associated spin-offs has kindled huge interest in the area the story depicts. The depiction of the changing countryside has also tapped into a new interest

and nostalgia for rural life amongst the growing urban middle-class. As in the West, there is now a desire to know more about 'the rural'. Therefore, by linking tourist activities to the famed local author, with the scenic area and surrounding locale named after his book, there has been a deliberate attempt to tap into a growing zeitgeist. This directly echoes tourism marketing found in the West, with the use of literary references to sell certain places, e.g., Agatha Christie Country [61], Anne of Green Gables [62], and including the creation of mythical places connected to literature, such as Hobbiton, in New Zealand, based on the The Lord of the Rings novels [63].

In the case of Xi'an's hinterland, the on-farm tourist development via the FJM has also tapped into an interest in gastronomic tourism, cementing a much closer relationship between farming and tourism than previously existed. The farmers interviewed in this study claimed that the tourists were seeking something different from their regular fayre, with the word 'authentic' used frequently. This referred to the idea that the tourists were seeking an experience that could involve eating local food, cooked on the farm and consumed in a rural farmhouse setting. In several cases, the farmers contended that this was either a central part of the visit to the area or a very important reason for the visit. This has been expressed by Quan and Wang [64] (p. 302) as "a part of the attractions in destinations, no less significant than other attractions, such as landscape or amusement park. In other words, the gastronomic experience can become a major, or one of major motivations, for travel". Gastronomic tourism offers the farmers a prime opportunity to add value to their produce and increase their income. Hence, the combination of the literary and gastronomic dimensions represents a major contribution towards making tourism development in the area sustainable.

3.5. A *desakota* Landscape?

One of the chief effects of the centrifugal growth of Xi'an-Xianyang has been the tremendous fragmentation of land uses in the rural-urban fringe. The remaining farming communities are now interspersed amongst urban developments, with former farmland occupied by new residential, industrial and service complexes. Several factors have contributed to this pattern. First, more manufacturing and processing industries have been developed by individual villages, in the form of so-called township and village enterprises (TVEs). These have been promoted by government and also funded by available capital at village level as additional income sources for farm households while absorbing some surplus farm labor [65,66]. There are two examples of TVEs in the study villages. In Duling the villagers have formed an association with an express transport company that delivers fruit both locally and to various metropolitan centres. In He village residents have established a marketing company that helps sell their vegetables through this channel, which has a distinctive brand associated with a quality guarantee. This has further increased the growth of non-agricultural income [67].

Secondly, a huge expanse of farmland was lost from 2010 with the designation of the Xi'an-Xianyang New Area, covering 560 km² and administered by the provincial government. There are similar developments associated with other major Chinese cities, e.g., Tianjin's Binhai New Area and Chongqing's Two Rivers New Area, all supported by a combination of investment from provincial and central government [68]. According to Jaros [69], in the Xi'an-Xianyang New Area there has been an investment of "several billion yuan of start-up capital for infrastructure, making available enormous tracts of land, extending a sweeping array of preferential policies to investors, and kicking off several major investment projects in the zone".

The New Area is part of the WDS, launched in 2000, and has involved substantial growth in manufacturing industry (notably machinery equipment, transportation, aerospace, petroleum and chemical engineering), including transitioning into high value-added sectors, such as biomedicine, electronic components and software development [70] (p. 124). Several of the new ventures have been on a large-scale, notably Samsung's US\$7 billion development in 2012 to establish a production facility for flash memory drives. Thirdly, in addition to the New Area there has also been the creation of several other new development 'hubs' around the metropolitan fringes, eight in total, as in the

case of the airport zone, which has been substantially upgraded and is now China's eighth busiest airport in terms of passenger throughput [71]. Xi'an's designation as a national innovation pilot city by the Ministry of Science also emphasizes its role as an education city, hosting 63 colleges and universities and a tertiary student population near one million. The service sector has been boosted by an 'explosion' of tourist-related businesses, spearheaded by attractions like the Terracotta Warriors, with 100 million tourists per annum exceeded in 2013 [72].

Viganò [73] refers to the rapid centrifugal growth of the metropolis as 'horizontality', creating new locales for employment often far removed from the actual metropolitan center. This represents a new urban ecology, creating a redefinition of relationships between open and built space, agriculture, water supply, forest and new urban forms [74]. Instead of the formerly distinct rural-urban dichotomy, this has been replaced by a dynamic inter-mingling of land uses, creating new inter-connections between urban and rural, city and farm, that are blurring boundaries, borders and flows. This description resembles that referred to in the so-called *desakota* landscapes observed by McGee [75] across south-east Asia and which are now receiving attention from researchers around China [76–79]. Another label comes from X. Liu et al. [80] who describe the emerging peri-urban landscape as semi-urbanization, which they assess as accounting for around two-thirds of the urbanization in Shaanxi province from 2000 to 2010 (around the national average). In the *desakota* landscape the remaining farmers are part of a multi-functional environment, in which they themselves have become multi-functional in order to survive, combining intensive farming with other enterprises, notably tourism and income generation from other activities ancillary to farming.

4. Conclusions

The transformation of the Chinese countryside has been at its most intense closest to fast-expanding metropolis. The rate of growth of the largest cities has been phenomenal, some of the most rapid urban expansion in the world in the last forty years. While urban expansion associated with this growth has consumed large quantities of farmland at the edge of the fast-moving urban envelope, two distinct types of surviving villages can be observed in the hinterland of Xi'an-Xianyang. One is typified by two of the study villages discussed herewith (Duling and He), which have experienced a major intensification of farm production, through a wholesale shift from traditional grain production to horticulture. The nearby metropolis has provided a substantial market for fruit and vegetable crops, triggering innovation amongst the farm households. This has been manifested in a process of horizontal specialization with some villages focusing on fruit production (e.g., Duling) and others on vegetables (e.g., He). Further away from the metropolis, Majia typifies the 'hollowed' villages now widespread across the country. Here the main urban impact has been in the form of rural-urban migration so that the village is depopulating. It continues to rely on grain production, but government grants have enabled adoption of new varieties and mechanization. Nevertheless, the production function has declined in contrast to that in the other two villages.

Both He and Duling have survived the enveloping urban sprawl of the metropolis not only through farm intensification, but also by diversification as part of an evolving multifunctionality. In the case of Duling this has involved major farmhouse-based tourist development as part of the Farmhouse Joy Movement, attracting tourists to eat in farmhouse restaurants and cafes, as well as purchasing produce direct from the farm or via pick-your-own schemes (cherries in this case). Nearby, major government-supported investment in the creation of a tourist village is also exploiting gastronomic and literary tourism, drawing on the association with famed local author Chen Zhongshi. The villagers in He have not developed tourism services as much as Duling, but there are plans for significant expansion. Both villages have participated in TVEs, a common way in which peri-urban fringe villages have diversified to gain income. This has contributed to the mixed pattern of land use that some have likened to the *desakota* pattern typical of south-east Asian cities. The dominant elements in this landscape are the major new urban-industrial complexes that are part of the massive Western Development Strategy, typified by new towns and an emphasis on new technologies. They provide new sources of

employment for the villagers, enabling some villages to retain population as residents commute to jobs nearby or in the metropolis itself.

The new landscape of the peri-urban fringe is one in which substantial amounts of land have been lost to urban-industrial development. Despite this, farming has remained important in some villages, surviving by intensifying and diversifying. As a result, output in the horticultural sector has hugely increased and where grain is still cultivated yields are higher than forty years ago. Farms have become multi-functional, with individual farms participating in the tourism sector and contributing to investment in TVEs.

For the farmers the transformations to the economy and society have provided various positive stimuli to which many have responded by substantially changing their own activities. The move from collectivism to individual responsibility has enabled innovation through intensification and diversification. However, many of the farms are small, only a few hectares, so participation in downstream activities and tourist enterprises has been vital to maintain incomes. Survival is not guaranteed for those still farming the land, but the high demand for fruit and vegetables should ensure that both Duling and He can maintain an agricultural future, perhaps with some consolidation of enterprises and reduction of plot fragmentation. For Majia, ongoing government support for grain production is likely to maintain wheat growing as the main land use, but perhaps with even less labor, and fewer remaining households directly involved in production.

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