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Influence of policy measures and economic growth on intercropping systems in China

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Introduction

Highly intensive agricultural practices in China lead to decreasing land and water resources and endanger sustainability severely. Intercropping the simultaneous cultivation of two or more crops in the same field is a traditional production system in China. Due to its potential to produce high yields with limited environmental resources, reduced leaching and erosion (Keating and Carberry, 1993; Tsubo et al., 2001; Walker and Odingo, 2003) it is an alternative production system that could counteract the current resource degradation. In the last decade intercropping became a hot topic in agronomic research in China (Gao et al., 2009; Li et al., 2001; Zhang and Li, 2003). Research findings invariably confirm the advantages of intercropping over monocropping. However, in the course of the rapid economic development also agricultural production systems are changing quickly in China. The question evolves whether and how the traditional concept of intercropping is able to meet the demands of modern agriculture. The current paper describes the socio-economic transformation agriculture has gone through in China in the last decades. Build on that we try to answer the question: what is the future of intercropping in China.

Materials and Methods

A qualitative inquiry was conducted in Hebei province. Stakeholders involved in developing, disseminating and practicing intercropping, were included in the survey. Local farmers, employees of the state extension service from local to provincial level and agricultural researchers, who are engaged in intercropping research, were interviewed. The main goals of the survey were to i) understand how and why farmers practice intercropping ii) understand factors influencing dissemination, improvement and adoption of intercropping; iii) understand farmers' knowledge, awareness and perception of different intercropping components; and, iv) identify chances and constraints of intercropping systems. Semi-structured in depth interviews, as described by Case (1990) were conducted. As the goal of the study was to obtain the greatest possible information from the cases in the sample, snowball sampling (Garforth and Usher, 1997) was applied. The survey was conducted from October 2007 to April 2008 with the help of a previously trained interpreter. More than 60 hours of recorded interviews and numerous written down interview reports were evaluated. Additionally literature and statistical data were consulted to understand current trends in the agricultural sector in China and get an idea of future developments of cropping systems and especially the distribution of intercropping.

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Results and Discussion

Four main drivers were recognized that influence the distribution of intercropping in time and space.

Land fragmentation

The case of unconscious strip intercropping happens due to the given small plot sizes in China. In average farm households cultivate less than half a hectare (National Statistical Yearbook, 2008). Dong et al. (1996) reported that each household cultivates more than five plots with an average plot size of 0.07 hectare. The extreme land fragmentation evolved as a consequence of the implementation of the household responsibility system beginning of the 1980s. Land within each village was classified according to quality and then allocated equally among farm households (Tan et al., 2006; Dou et al. 2007). It often occurs that farmers grow different crops in neighboring fields. The crops of the neighboring plots influence each other above and below ground, especially in the rows near to the neighboring crop and can thus be considered as intercropping. The result of the scattered landscape is a high agro-biodiversity with positive effects on pest and disease control. However, the extreme land fragmentation is a strong constraint to increasing production efficiency and thus land consolidation became an issue in China.

Unconscious strip intercropping is most likely to reduce slowly but steadily in the future. Dong et al (1996) still observed a decrease in average plot size from 0.08 ha in 1986 to 0.07 ha in 1990. In contrast to the government, which realized fragmentation as a contradiction to productivity and progress, interviewed farmers didn't perceive land fragmentation as detrimental. However, land consolidation has been put on the agenda and set as an urgent task in the "eleventh five year plan" of the state council of the People's Republic of China (Dou et al. 2007). Even though radical changes in land consolidation policy are unlikely to happen, especially with the current system of land allocation on village level (Tan et al., 2006), land fragmentation and along with that unconscious intercropping is considered to reduce steadily in the next decades (Wan, 2001).

Green belt policy

A policy that encourages intercropping, at least in short term is the establishment of 10 to 50 meter wide strips of trees along major roads. The policy tries to counteract the severe deforestation many parts of China have gone through in the last decades. The tree strips act as a wind break and contribute positively to the overall appearance of the landscape. Depending on the spacing and tree species the land under the trees can be used for the first three to five years after planting (Fig. 1a,b). When competition by the growing trees becomes too strong and impedes satisfying crop yields, farmers abandon the land (Fig.1c). Until then agroforestry-systems are practiced all over the country.



Figure 1. Tree strips along roads in Quzhou county, Hebei province. A: year 0; B: year 3; C: year 4.

Economic development

The tremendous economic growth not only changed people's life in the economic centers along the eastern coastline, it also has a strong impact on rural China in the last years. A lack of alternatives still predetermined people's career as a farmer one generation ago. In contrast

nowadays' youth often doesn't see its future tilling the family's fields. In the past agricultural production was limited by the production factor land, whereas input of (cheap) labor was inexhaustible. Rural farm households had to generate all income from their land and thus invested all available manpower in agriculture. In recent years however, steadily increasing off-farm income possibilities lead to increasing opportunity costs and thus farm households invest less and less time to their fields. The share of farmers working mainly in agriculture is reducing steadily since 1990 (Fig. 2). Since the end of collective management beginning of the 1980s the contribution of agricultural production to the income of rural households is constantly shrinking (Fig. 3). With this trend continuing in the future labor intensive systems, especially those demanding a lot of manual labor like intercropping will reduce.

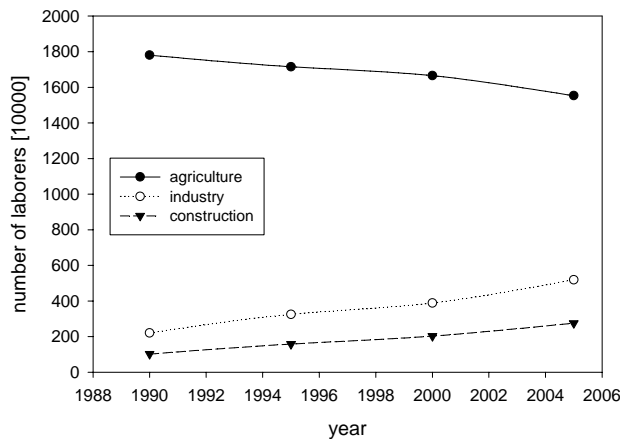


Figure 2. Number of rural laborers per sector in Hebei (Source: Hebei Statistical Yearbook, 1999-2008).

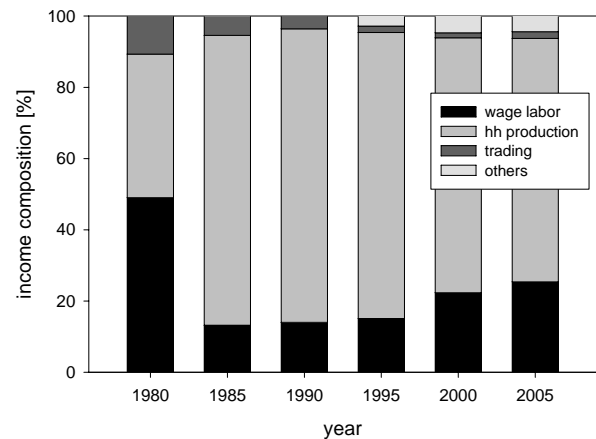


Figure 3. Income composition of rural households in China (Source: China Rural Household Survey Yearbook 2000-2008).

Mechanisation

Use of agricultural machinery is rapidly finding its way into Chinese agriculture. From 1985 to 2007 the number of tractors in Hebei province increased from 320000 to more than 1.5 million

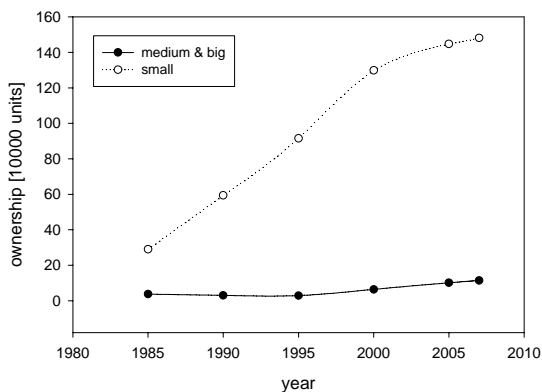


Figure 4. Ownership of tractors in Hebei (Source: Hebei Statistical Yearbook 2008).

It is a consequence of both increasing labor costs and availability of capital as a production factor. This development has a tremendous impact on the design and management of cropping systems. Most intercropping systems in China are row intercropping systems with alternating rows of two different crops (Fig. 5). These systems significantly overyield their monocropping equivalents by a more efficient resource use and in the past enabled farmers to make optimal use of their limited land resources. Such row intercropping systems can hardly be mechanized and are most likely to disappear in the long run. In strip intercropping systems, on the other side at

least part of the management measures can be accomplished by machines. Positive effects in strip intercropping were already identified by Capinera et al. (1985) up to a strip width of eight meters. With the majority of tractors used in China having a small working width of less than two meters, strip systems seem an appropriate solution that makes use of existing synergisms.



Figure 5. Typical row intercropping systems in Hebei province: maize – Chinese cabbage relay intercropping (left) and garlic – spinach intercropping (right).

Conclusion

The steadily changing socio-economic conditions in rural China endanger the future of intercropping, a traditional and sustainable production system. In the process of land consolidation unconscious strip intercropping will strongly reduce. Agroforestry systems along roads are only temporarily increasing the area of intercropping. The strongest (negative) impact however has the change in production factor endowment. In the past land and capital limited the production, with labor being inexhaustibly available. With increasing off-farm income possibilities, increasing labor costs and sufficient capital a shift into less labor intensive, mechanizable systems is taking place. If intercropping is to play a role in Chinese agriculture in the future existing systems have to be improved. Either promising intercropping systems have to be adjusted to mechanization or agricultural machinery has to be developed that enables sowing and/or harvesting in row intercropping systems. One or the other way – only an interdisciplinary approach can be successful. Agronomists have to work closely together with agricultural economists and engineers to develop superior systems that can be applied in the field.

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