Perspectives for Intercropping in Modern Agriculture

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COLUMN ARTICLE

Intercropping refers to growing two or more crop species on the same pieces of land at the same time, which is one of the traditional farming systems practiced by farmers for more than 2000 years in China [1]. To date, intercropping has been distributed not only in China, but also in other part of the world [2-4]. Previous studies have shown that reasonable intercropping can use light, heat, water, fertilizer and other natural resources efficiently [5], enhance crop productivity, strengthen ecosystem services and functions in the agroecosystem by increasing crop diversity at field scale [6,7].

A four years' field study showed that maize (*Zea mays L.*) over yielded by 43% and faba bean (*Viciafaba L.*) over yielded by 26% when intercropped compared with respective monocultures in the low-phosphorus but high-nitrogen relatively fertile soil in Northwest part of China [8]. Intercropping can also increase the productivity stability of agricultural ecosystems [9]. At four regions with different elevations in Africa, the variation coefficient of maize grain yields is smaller (9% - 16%) in maize/perennial crop intercropping and annual legume/maize rotation than those (17% - 30%) in the maize monoculture system [10].

Legume/cereal intercropping can improve the protein content of forage by mixing higher protein concentration of legumes into lower protein concentration of cereals [11]. Intercropping can also control crop weeds and pests by increasing genetic and species diversity in agroecosystems, which help to reduce the use of herbicides and pesticides and alleviate environmental pollution [12].

There are above and below-ground interspecific interactions between intercropped species. The above-ground interactions increase light interception complementarity across temporal and spatial scales [12]. Below-ground interspecific interactions mainly include that the root distribution of intercropped crops in temporal and spatial differentiation to reduce the interspecific competition [12], that some species can enhance one or more limited nutrient (phosphorus, iron, manganese, or zinc etc.) availability in soil, and thereby improve the nutrition of associated species that has less ability to mobilize these sparingly soluble nutrients [10]. Symbiotic N_2 fixation of legumes intercropped with cereals is usually enhanced either by soil N competition [13] or by stimulating effect of root exudates by associated cereals [14].

In the applied aspects, by intercropping, firstly, legumes may be involved in agricultural production systems to larger extend to develop ecologically intensive agriculture targeted at symbiotic N_2 fixation in the area with limited arable land per capita [6]. Secondly, Intercropping can be one of ways for developing organic agriculture, by making full use

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of ecological principles of intercropping, such as symbiotic N_2 fixation and control disease, to meet the requirement of organic production on farm. Thirdly, intercropping can be used for improving the utilization of phosphate fertilizer and microelement enrichment of crop seeds [17-18], which may benefit to micro-element of human body.

However, development of intercropping, two key problems must be solved for intercropping-based intensive agriculture in large scale of farms. One will be suitable machines for sowing, fertilization, and harvest etc. because mechanization is bottleneck for intercropping development. The other is suitable crop varieties for intercropping, which need to consider crop traits for intercropping, such as plant height, growth stage, leaf architecture and roots [19].

In summary, intercropping can be one of ways for developing ecologically intensive agriculture, with reduction of chemicals applied, if some key issues will be solved.

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