

Introduction to Volume

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Over the last 25 years sweetpotato has undergone a fundamental transformation in China. Sweetpotato has changed from being a major staple food to become a major source of animal feed and raw material for food processing industries. While direct food use of sweetpotato in China has declined dramatically, production has actually grown, as the new uses have generated more demand for the crop. In this way sweetpotato continues to serve China's farmers well, and China continues to be by far the world's largest sweetpotato producer, accounting for about 85% of global production.

To help farmers adapt to these new outlets for sweetpotato, Chinese agricultural research institutions have worked to develop better ways of utilization sweetpotato. In the late 1980s, the International Potato Center (CIP) began to collaborate with Chinese scientists on post-harvest utilization of sweetpotato. Much of the early collaboration focused on Sichuan, then and still the largest sweetpotato-producing province in China. Initially, this collaboration focused on introducing and improving machinery for small-scale starch extraction and noodle making. This collaboration achieved some successes, and by the mid 1990s these improvements were being extended and adopted by machinery manufacturers and sweetpotato processors. Previous CIP publications reported on this research and attempted to draw from it some general lessons for sweetpotato processing and product development research (Scott et al., 1992; Wheatley et al., 1995). Later, CIP-supported research expanded to include aspects of organization and management of processing enterprises (Wheatley et al., 1997) and the marketing of sweetpotato processed products (Zhang, 1999).

By the late 1990s the households and small enterprises that had adopted sweetpotato for animal feed and starch/noodle processing faced growing competition in China's rapidly advancing market economy. Household pig producers who relied heavily on sweetpotato to feed their animals saw their market share gradually decline, giving way to larger-scale pig farmers who used primarily cereal grains and manufactured formula feed. Small-scale noodle makers faced growing competition from modern food manufacturing firms that could produce higher quality products and market them nationally. Research by Chinese and CIP researchers turned increasingly toward questions of scale and efficiency. In particular, scientists sought to develop technologies that were particularly suited to address the constraints faced by small-scale users of sweetpotato in order to make them more productive and competitive. The present volume updates us on the progress of the research on post-harvest utilization of sweetpotato in China. The papers included in this volume were first presented at a meeting held in Sichuan in November, 2001. All of the papers were subsequently revised and updated.

Section I includes two general papers on different aspects of sweetpotato post-harvest development in China. Chapter 1 by Huang Jikun et al. provides an historical perspective on the evolving role of sweetpotato in China's agricultural economy. By

surveying expert opinion, the authors develop new estimates of the trend in sweetpotato utilization in China over time. They show the rapid expansion of feed and industrial utilization of sweetpotato following the reforms first introduced in 1978 to make the Chinese economy more market-oriented. Huang Jikun et al. also show that farm yield of sweetpotato, though improving, has lagged behind yield growth of major cereal grains over the past 30 years, a consequence of relatively low investment in sweetpotato research compared with that of rice, maize, and wheat. In Chapter 2, Zhang Dapeng and Li Xiu-Qing review the rationale and feasibility of changing the principal nutrition quality traits in sweetpotato through genetic means especially through the improvement of energy digestibility and raising dry matter/starch yield. Collaboration in sweetpotato breeding between CIP and China is strongly oriented toward such post harvest utilization. The payoff from this international collaboration should start to be seen in farmers' fields before the end of this decade.

Section II of the volume focuses especially on utilizing sweetpotato as feed in hog production. Li Xianglin lays the groundwork for the section in Chapter 3 by describing China's role in the global "Livestock Revolution." The Livestock Revolution refers to the projected global doubling of demand for meat and animal products between 2000 and 2020, with most of this growth occurring in developing nations. China is clearly already in the midst of this revolution as evidenced by its rapidly rising consumption of animal products. China faces the prospect of large deficits in feed grain and protein supply to meet this rising demand. New technological innovations are needed to improve productivity of animal production, especially to get more product per unit of feed.

The next two papers (Chapter's 4 and 5) of Section II turn to economic analysis of sweetpotato and pig production in China. In Chapter 4, Huang Jikun et al. construct a Policy Analysis Matrix (PAM) to compare the private and social costs of sweetpotato and maize production in the two most important sweetpotato-producing provinces in China, Sichuan and Shandong. In both provinces, sweetpotato is widely employed as pig feed. They find that in the current policy environment maize is generally a lower-cost feed than sweetpotato, but that its cost advantage disappears once the effects of policy distortions are removed. The results show how policies may unintentionally favor one commodity over another with serious consequences for China's farmers. (For an expanded version of this analysis, see the separate publication by the authors published by CIP in 2003). In Chapter 5, Zhang Xiaohui and Agapi Somwaru draw upon a large and recent national survey of hog producers to examine feed utilization patterns and economies of scale in pig production. They find that while more than 80 percent of pig production is by small-scale "backyard" producers, these farmers face a declining market share and are less efficient than middle-scale specialized producers. The importance of sweetpotato as an animal feed varies widely by scale of operation and by region. Tuber crops (mainly sweetpotato but also potato), which are classified here as a component of "fine grain" along with cereals, manufactured feed, and oilseeds, contribute a large share of total grain used for feed in the more isolated, interior provinces of China such as Sichuan and Guangxi. Sweetpotato tops (the vines and leaves) are also fed to animals and are especially important because their per unit dry matter provide substantially more protein than sweetpotato roots. Sweetpotato tops make up a significant proportion of total feed among for small-scale hog producers in

Sichuan. But backyard pig producers generally achieve lower levels of feed-to-meat conversion compared with larger-scale producers. These findings indicate both a challenge and an opportunity. While small-scale producers facing increasingly stiff competition in animal production, improving the sweetpotato-pig production system may be a way for policy makers and scientists to achieve “pro-poor” agricultural development. The sweetpotato-pig production system appears to favor small-scale producers who tend to be relatively low-income rural households, often run by women. Prospects for improving the sweetpotato-pig production system in Sichuan are investigated in Chapters 6 and 7. In Chapter 6, Zou Chengyi et al. report on conditions faced by households raising pigs from sweetpotato in Sichuan. The authors find that pig nutrition is generally poor, with serious deficiencies in protein, lysine, and other nutrients. Significant increases in animal weight gain can be achieved by adding commercial protein concentrates to the sweetpotato-based animal diet, but farmers often lack sufficient resources to purchase these ingredients. In addition to unbalanced diets, another inefficiency in the sweetpotato-pig system is wastage following harvest since sweetpotato roots and vines do not store well. In Chapter 7, Li Zouhua et al. report on experiments conducted with ensilaging sweetpotato roots and foliage as a means of improving nutrient availability and storability. They find that through ensilaging, sweetpotato can be stored as high quality feed for as long as six months. They report evidence from pig feeding trials showing that significant gains in feed-to-meat conversion are possible on diets composed of 20% sweetpotato silage and 80% basal grains.

Section III turns to sweetpotato utilization for food processing, especially for starch and starch-based products. Fuglie and Oates in Chapter 8 describe the supply and demand of starch in Asian markets. Tropical root crops (sweetpotato and cassava) supply about half of all starch consumed in Asia. This fact is often missed in government and industry statistics on starch since much of the processing from root crops is done by the informal sector. Root crop starch extraction tends to be done by small-scale enterprises located in farming areas because of the crops’ bulkiness and perishability. Uses of starch are varied, although most sweetpotato starch appears to be used for noodle production in China. The authors present evidence that the demand for starch is likely to grow very fast as Asian economies develop. In Chapter 9, Xie Jiang et al. review the research and development activities of the Sichuan Academy of Agricultural Sciences on sweetpotato processing and product development. While work initially concentrated on improving small-scale starch and noodle processing, it has since expanded to include process and product development of instant noodles, snack foods, and flour products. The sweetpotato processing industry is also undergoing structural changes, with large-scale modern food manufacturing companies playing an increasingly larger role in sweetpotato processing. Interestingly, much recent product development has been inspired by traditional Chinese recipes. Traditional batch-wise village processes needed to be translated into continuous large-scale processing suited to industrial conditions.

In this market environment, small-scale starch and noodle processors face similar challenges to those faced by small ‘backyard’ pig growers: will they be able to compete with more efficient larger-scale producers? Chapter’s 10 and 11 report on research aimed at improving the efficiency and quality of output from small-scale

sweetpotato starch processors. In Chapter 10, Hu Jianjun examines the effects of different combinations of milling methods, starch separating meshes, and starch precipitation methods on starch extraction rates and starch quality. He finds that there may be a tradeoff between achieving higher extraction rates and starch quality – getting more starch out of the tuber may also let in more impurities. In Chapter 11, Piyachomkwan et al. report on a series of experiments designed to establish protocols, or best management practices, for small-scale starch / noodle processors. The key to supplying a consistently high-quality starch noodle is to use a starch with the appropriate characteristics (especially, high purity and high amylose content). However, Piyachomkwan et al. find wide variation in sweetpotato starch quality from samples taken in a survey of small-scale processors in Sichuan and Shandong provinces. They recommend using a consistent sweetpotato variety, consistent post-harvest handling and storage methods, and consistent best management extraction methods to upgrade starch quality for noodle making.

One of the outcomes of the November 2001 workshop was an agenda for future sweetpotato post-harvest research and development in China. One key research area is to continue sweetpotato breeding for post-harvest utilization, especially for starch and also for animal feed. CIP is playing a crucial role in developing enhanced sweetpotato germplasm with high starch yield and introducing this germplasm into China for use as parent material to develop locally adapted lines. To improve feed utilization, we are fortunate to have the International Livestock Research Institute (ILRI) joining this effort. In 2001 ILRI established a scientific liaison office in China and expanded its research interest to include monogastric animals such as pigs. Beginning in 2002 ILRI established a research site in Sichuan as part of the Asia-based Crop-Animal Systems Research Network (CASREN) to conduct applied research in sweetpotato-pig systems. CIP-ILRI-China collaboration in crop-livestock systems research brings a wider set of scientific and technical strengths to bear on addressing the constraints faced by small pig growers. Regarding starch utilization, CIP and SAAS initiated a new study to understand the structural changes taking place in the sweetpotato food processing sector. Results of these and related studies should be forthcoming in the near future.

References

- Huang, Jikun, Jun Song, Fanbin Qiao, and K. Fuglie. 2003. *Economy of Sweetpotato And Its Use as Feed in Pig Production in China*. Bogor, Indonesia: International Potato Center.
- Scott, G., S. Wiersema, and P.I. Ferguson (eds.). 1992. *Product Development for Root and Tuber Crops: Volume 1 – Asia*. Lima, Peru: International Potato Center (CIP).
- Wheatley, C. G. Scott, R. Best, and S. Wiersema. 1995. *Adding Value to Root and Tuber Crops. A Manual on Product Development..* Cali, Colombia: International Center of Tropical Agriculture (CIAT) and International Potato Center (CIP).

Wheatley, C., Lin Liping, Sun G. and Song Bofu. 1997. Improving small-scale sweet potato starch enterprises in Sichuan Province, China. *Tropical Science* 37:228-237.

Zhang, Xiaoyong (1999). *Agricultural Marketing in a Country in Transition: Case of Sweetpotato Products in Sichuan P. R. China*. Mansholt Studies 13, Wageningen University, The Netherlands.