Title: Sweetpotato Processing for Poverty Alleviation and Rural Stability in China: A Case Study of Yilong County in Sichuan

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Abstract

An analysis of the household economy of a sweetpotato-producing county in Sichuan Province of China shows that sweetpotato is currently under-utilized in an inefficient sweetpotato-pig feed system. Meanwhile, poverty drives many young men and women to seek employment opportunities in major coastal cities far from home. This paper reviews the contributions of sweetpotato, pig-raising, and migration income in the household economy in order to investigate whether sweetpotato post-harvest activities in modified pig-raising and starch/noodle processing may lead to a substantial increase in household income. Comparing the local pig growth with a recently conducted pig trial in Vietnam, the results show that the modified practice generates greater income. A cost-and-profit analysis of starch/noodle processing, estimated from on-going processing activities in other counties in Sichuan, shows added value for each ton of sweetpotato, especially for noodle processing. The potential income gains from combinations of modified pig-raising and starch/noodle processing exceed the current migration income, suggesting some hope for alternatives to migration. The paper concludes with policy recommendations to proceed with research and development endeavours for sweetpotato post-harvest utilization.

Introduction

Migration from rural areas to cities has become a strategy to capitalize on a household's extra labour and ensure household survival and improvement (Massey, 1990). This has become a global phenomenon as the gap between rural and urban income continues to increase world-wide. Failure to improve rural income has resulted in the exodus of farmers seeking alternative labour employment. This migration process is particularly intense in densely populated rural China where excessive labour lacks local employment opportunities. An estimated 100 million "floating population" in China contribute to rural instability as families suffer from long-term separation. As these low-skilled or unskilled migrants put pressure on the cities, their mobility has become a challenge for scholars for some time (Chan 1996). Agricultural policies focusing on rural development and income generation opportunities are needed to provide migration alternatives.

Rural development is frequently limited to identification of problems/needs, and their resolution/satisfaction. The identification and realization of relevant opportunities is often neglected, potentially leading to misallocation of resources (Chambers, 1993). Rural poverty can be seen either as a problem or as an opportunity for income generation. Small-scale enterprises that process primary agricultural products offer rural households a means of adding value to their crops, of diversifying markets, and, more importantly, of raising incomes. For example, Grabowski (1995) argues that rural non-agricultural activities lead to farmer innovation, increased agricultural productivity, growth in the size of domestic markets, and consequently to economic development in Europe, Japan, Taiwan, and Korea. Park and Johnston (1995) also attribute the development success in Taiwan to higher rural incomes which generated market demand and increased available funds for education and health, and capital for rural enterprises, all of which contributed to the development of the country.

Root crops offer much potential for rural income generation through small-scale processing (Wheatley et al., 1996), being efficient producers of carbohydrates capable of transformation, using low cost technologies, into stable intermediate goods (starch and flour), and suitable for diverse markets in the food and feed industries. Cassava is processed into many traditional products on all continents, while more recently becoming a raw material for the food industry in several developing countries (e.g., Indonesia, Brazil, and Thailand). Projects aimed at introducing cassava processing to communities which previously only consumed fresh root have been successful in Latin America (Best et al., 1991; Henry, 1992).

Sweetpotato, the second most important tropical root crop next to cassava, is also processed into starch, mostly at the household enterprise level (Marter and Timmins, 1992). Accounting for eighty-five percent of sweetpotato production in the world, China's sweetpotato consumption has declined over the years as living standards have increased. For example, in an extreme case of Shandong Province, a major sweetpotato producing province, forty-eight percent is allocated as industrial raw material, thirty-five percent as animal feed, ten percent for fresh consumption, and seven percent used as seed (Wang, 1998). In Sichuan Province, small-scale process innovations have also diffused rapidly throughout sweetpotato starch processing households, increasing both efficiency and income generation potential (Wheatley et al., 1997). This trend coincides with that in Indonesia where per capita fresh consumption declines as income increases (Gunawan, 1996), and only sixteen percent of sweetpotato is consumed by the producers--73.8 percent of production is for the market (Heriyanto, 1995).

Income from sweetpotato may increase by two avenues: 1) improving the pig-feed system, and 2) processing fresh roots into a variety of product, such as starch and subsequent products. Improving sweetpotato post-harvest utilization, in this case, has the potential to increase household income, discourage out-migration, and hence contribute to rural stability in general.

The goals of this study were to identify further research needs and to formulate policy recommendations for sweetpotato utilization for income-generation and poverty alleviation, using Yilong county as a case study. In addition to having implications for Chinese national agricultural development policies, these results are also relevant for other poverty-stricken sweetpotato-producing areas in many parts of Asia and Africa. The specific objectives of the study were as follows:

1. To describe the anatomy of the household economy in Yilong;
2. To analyze the relative contributions of migration income and the current sweetpotato value to the general household economy;
3. To examine the potential income generated by sweetpotato processing and the modified sweetpotato-pig feed system; and
4. To project the potential impact of introduced post-harvest sweetpotato use on household economy and migration.

Why Yilong?

Poverty and Migration

Sichuan, boasting a population of 120 million, is the most densely populated province of China. Although an agriculture-based province, arable land is scarce for this large population, resulting in poverty throughout the province. Long- and short-term migration for off-farm employment to supplement the insufficient income generated by farming and livestock-raising has created a mass exodus of young men and women from rural Sichuan. The situation is further intensified in Yilong, one of the poorest counties of the province with a population of 960,000 of which 400,000 are below the poverty level (Gao Xiangjun, director of Yilong Project Office, personal communication).

Poverty-alleviation Projects and the Project Office

Declared a poverty-stricken county by the central government, Yilong County set up a project office in order to raise and manage funds from the central government, and outside sources, to alleviate poverty. Owing to a capable director and with a reputation for being an excellent fund-manager, Yilong has been rewarded copious project funds. These projects aim to alleviate poverty through a number of rural development activities, one of which is to improve sweetpotato post-harvest utilization (i.e., starch and noodle processing and sweetpotato fast-food production) because of the large amount of sweetpotato production and the low fresh-market prices. Furthermore, some small loans have been granted by the United Nations Development Project (UNDP), all of which have included pig raising activities to one degree or another.

Sweetpotato Production and Utilization in Yilong

Sweetpotato, along with rice, wheat, and maize, is an important crop in Yilong County, producing 400,000 tons of sweetpotato a year. However, the low price of the fresh roots (0.2 yuan[1] kg^{-1}) makes sweetpotato unprofitable as a cash crop. Most of the sweetpotato is fed directly to pigs, which provide food as well as a scarce source of cash income. However, this traditional feeding method may not be the most efficient way of utilizing sweetpotato because: 1) a preliminary study showed slow pig-growth; 2) in other counties sweetpotato starch and noodle processing has proved a more profitable alternative; and 3) the combined use of sweetpotato for pig feed and starch and noodle processing may be a more economic way of utilizing these sweetpotatoes. Currently, the sweetpotato processing technology has not yet reached Yilong, a remote county which had been isolated from Chengdu, Sichuan's capital city, until road construction was completed in 1998. With the improved road condition, the processing technology and processed products (i.e., starch and noodles) may be distributed to other parts of the province and country.

Methods

Household surveys in Yilong were carried out over two periods. The first wave of household surveys, consisting of ten households, was conducted in April 1996 during a preliminary study. Another eighteen households were interviewed during five weeks in October and November 1996 while I resided with a farming household. The survey data were complimented by numerous informal interviews and extensive observation during these five weeks.

Farming System and Household Economy

Examining the household economy is important because households provide a link between individual migration and macro social structure (Massey, 1990). The household economy in Yilong consists of farming and non-farming incomes. Due to diminishing land-holdings, as a result of increased population, farming activities generally do not absorb all household labour. Therefore, local non-farm activities and out-migration incomes are sought to fully utilize the excess labour.

Farming Activities and Incomes

The farmers identified crop cultivation on rainfed and irrigated fields, pig raising, and sericulture as the most important on-farm activities, even though these may no longer be the primary sources of income. These activities are important because they are traditional and tied to the land, and they provide food security and dependable, though minimal, income. Other secondary activities, such as fish farming and poultry (chickens and ducks) raising, also play a minor role in the household economy.

Crop Cultivation

The land allocated to each household varies with the amount of the land each community unit (*she*) owns, the number of people in each *she*, and the quality of the land. Farmland is divided into three grades--high, medium, and low quality--categorized according to soil fertility. Less acreage is allocated with high quality land and vice versa. Land appropriation is re-adjusted every three years, during which time the *she* reclaims land from those who have died and from the women who have married out of the village since the last adjustment and gives it to those who were born in and married into the village since the last adjustment.

Each person who is entitled to land is allocated, on average, .021 hectare of rainfed fields. The fields are intensely cultivated under a relay cropping system (Figure 1). Wheat is planted in October with intermittent rows set aside for vegetables, which are subsequently planted in mid-November. From mid-November to April, the fields are inter-cropped with wheat and vegetables. Vegetables are harvested in April and the rows are then planted with maize immediately after land preparation and fertilization. Wheat and maize are inter-cropped in the fields between April and May, after which the wheat is harvested. The harvested rows are immediately prepared and planted with sweetpotato, so that sweetpotato and maize are inter-cropped between May and July, at which time the maize is harvested. Once maize is harvested, sweetpotato vines overtake and occupy the whole field until the roots are harvested in October, making way once again for wheat cultivation.

Growing cotton is an obligation and a form of tax paid to the government, and certain quotas must be sold to the government, at a lower price than that of the market. Cotton is grown on a small area of rainfed field, relay-cropped with wheat (Figure 2). Like the rest of the rainfed field, wheat is planted in October in rows, with fallow rows in between reserved for cotton, which is planted in April. Between April and May, wheat and cotton co-exist in the field for about 40 days before the wheat is harvested. Cotton remains in the field alone until September or October when it is harvested, making way again for wheat.

The economics of the rainfed fields of the twenty-eight households was estimated from the values of each crop[2], minus the cost of seeds, fertilizers, pesticides, plastic covers, and hired labour for each crop (Table 1). On average, a household generates a gross value of Y1,738 (total costs = Y596), or Y10,423 of net value per hectare per year from the rainfed fields. The distribution of this gross value ranges from Y781 to Y3,840.

Cotton requires heavy investments (mainly in fertilizer) and the costs per hectare average Y3,354, which are considerably higher than for most other crops, except wheat which costs Y3,397 per hectare. Even though wheat is heavily invested, maize yields the highest value of Y3,580 of net profit per hectare, followed by vegetables (Y3,315). This, however, reflects the market value, and it must be pointed out that market value was used in an attempt to quantify the value of these crops. In reality, these crops are mostly consumed on farm: rice and wheat are prepared as staple foods for humans while sweetpotato, maize and vegetables are fed to pigs, which in turn generate scarce cash income. Each crop serves an important function in the farming system and their relative economic importance cannot, and need not, be established.

On average, each person is allocated .023 hectare of irrigated fields. These fields are cultivated under one of the following two patterns:

- **Two-season cropping**: Irrigated rice is planted in April and harvested by August, followed by land preparation for rape seed and/or wheat, which are planted in late September, with a small

area reserve for storing water. Rape seed and/or wheat is harvested in April when it comes time to plant rice again (Figure 3).

- **One-season cropping**: Rice is planted in April/May and harvested by August with no follow-up second crop and the fields are converted into reservoirs for storing drinking and irrigation water, and serving as fish and duck ponds, or rice nurseries (Figure 4). Households with no access to water during the dry season are limited to this option in their irrigated fields.

The average household generates Y1,657 of gross value, or Y10,641 of net value per hectare from the irrigated fields (Table 2). Rice is a high value crop (Y10,417 of net profit per hectare) mainly due to the staggering yields of nine tons per hectare on average, ranging from five to thirteen tons per hectare. According to local officials, the high yield is attributed to the improved hybrid variety that is centrally controlled and distributed by the government. Rice is mainly used for subsistence consumption and the extra grain is stored to ensure food security. Approximately sixty-one percent of all surveyed households have stored grain for six months up to two and a half years, averaging one ton per household. Part of the excess grain is the result of out-migration: fewer people consuming the grain produced from the fields allocated to all the household members. Material inputs such as fertilizers and pesticides account for much of the high grain production in general from the limited land base. However, the head of Zhanggong Township, Yilong County, revealed that "each year we must increase fertilization rates five to ten percent to maintain the same productivity." (Mr. Li, personal communication). In addition to increasing the cost of crop production, "increased use of agricultural chemicals has caused serious environmental problems in China" (Wen et al., 1992:56).

Pig Raising

Even with low profits, the farmers regard pig-raising with great significance because it serves three important functions: 1) the sales of the pigs generate one of the few sources of cash income, 2) it provides manure for maintaining soil fertility, and 3) pigs convert the undesirable and low-valued sweetpotato, vegetables, and grass into highly desired food and highly marketable commodities. On average, each household generates Y2,600 of total income, or Y731 per pig, from pig-raising. However, the value of manure cannot be ignored and it is estimated that each household, on average, gathers an equivalent of Y323 worth of manure from the pigs per household (i.e., the amount of cash inputs that would be required in the absence of the manure.)

Two systems of pig feeding were observed among the twenty-eight households. The most common is the traditional-feeding system (T) which uses no commercial feed, additives, or protein supplements. The feed sources in this system are sweetpotato, maize, rice and wheat bran, and light feed (vegetables, greens, and grass) all of which are mixed and cooked before feeding to pigs. The second type is the mixed-feeding system (M) which combines some commercial protein supplement for piglets with other on-farm available feed sources (Table 3). This system is not as commonly observed as it requires cash inputs.

Both systems are inefficient as T takes twelve months to raise pigs to approximately ninety-five kg, while it takes 10.6 months for M to raise pigs to eighty-eight kg (Table 3). M appears to be oriented more to commercial production because: 1) average household pig-holding size of M is 4.8 heads vs. 3.1 heads among T households, 2) eighty percent of M households spent Y12 on shots

and medication per pig to protect the pigs while only forty-seven percent of T households spent only Y5 on medical protection, 3) every M household sells pigs in the market, with total sales value of Y2,040 while they consume only Y716 worth of pork at home, whereas T households consume much more (Y1,661) than they sell (Y847).

When the value of the pigs is standardized to the market pork price (Y5.5 kg^{-1}), the total value and net value decrease for both types of households. The important result is that the M households then show higher net value per pig (M = Y125, T = Y60), but comparable profit ratio (M = .33, T = .32) (Table 4). The net value and profit ratio of pig raising decrease with a market orientation because live pigs sell for Y5.5 kg^{-1} while pork price in the market reaches Y10 kg^{-1}. The commercial orientation, therefore, contributes to lower real value (Y208 vs. Y369). However, since M households raise more pigs than T households, there are invariably more pigs for sale, even after reserving one or two for home consumption, thus the total income from pigs is higher than that of the T households (Y2,508 vs. Y2,756). This characterizes the difference between larger-scale production oriented towards market sales and smaller-scale production oriented towards home consumption: as the scale increases, the household can no longer absorb the entire production, therefore the product must be sold in the market below the retail price. In this case, the per unit profit decreases, but total profit is compensated by increased volume.

Sericulture

Sericulture is a common farm activity among sampled households (eighty-five percent) even though it has become a low-profit production due to the decrease in sales prices. The farmers grow mulberry trees, often on the borders of the crops, and feed the leaves to silkworms, the "eggs" of which are purchased from the government on sheets. Small investments are allocated for bamboo trays and nets on which the silkworms can grow. Few households specifically build a room for sericulture, even though this practice is believed to increase the survival of the worms and silk production due to better air circulation[3]. Once the worms reach the pupal stage, the cocoons are sold to government-owned silk factories. Even though the cash investment is not high, the labour input is significant. Thus, the total income from sericulture only averages Y309 per household, yielding Y123 of net income. The low profitability is partly attributed to the low collection prices in recent years ($\approx$ Y10 kg^{-1}), a significant decrease from Y15 kg^{-1} in the past.

Some households grow improved mulberry trees, which require pruning and grafting and higher material and labour inputs in order to supposedly produce a greater quantity of leaves which support more silkworms. For these improved trees, branches need to be pruned, and fertilizers and pesticides need to be applied four times a year. However, the high cash input requirements impede most households from investing in improved trees and most content themselves with low inputs and low return.

Fish Farming and Poultry Raising

Only a small percentage of households (eighteen percent) , located on the bottom land where water is available, are able to practice fish farming. These households derive low net annual incomes from fish farming, ranging from Y16 to Y153, and an average of only Y14 among these twenty-eight households. Chickens are more common than ducks but command lower prices. On average, chickens produce Y66 while ducks produce Y85 of net income for each household.

Non-Farming Activities and Income

Non-farming activities include both local activities and off-farm migrant work, generally in the rapidly developing cities on the east coast of China.

Local Non-farm Income

In addition to farming, farmers generate income with the following resources and activities: teaching, carpentry, roof tile manufacturing, brick manufacturing, driving, car & motorcycle mechanics, small businesses, serving as county-, village-, and brigade-level officials, painting, varnishing, basket-weaving, tofu processing, straw-mat weaving, various forms of local employment, and receiving government pensions. This is an important component of the total household economy and only 18 percent of households generate no income from local non-farming activities. These incomes range from as low as Y260 (basket weaving) to a high of Y23,000 (driving and car maintenance) per household. The average household income from these activities is quite significant (Y2,579) compared to income from farming activities.

Migrant Labour Income

Approximately half of the households (fifty-four percent) have one to four members out on migration. By far the most common destination is Guangzhou, where most of the female migrants work in factories while the men work on building construction. Migration incomes vary greatly depending on the experience of each migrant. Similarly, some households received up to Y7,000 from the migrants in 1996, others received nothing. Since only about half of the households (fifty-four percent) engaged in out-migration, the income from migration averages only Y1,305 per household.

Total Household Economy

In the anatomy of household economy, local non-farming activities generate the most income, while migration accounts for the second highest income for the households (Table 5). The incomes from the major farming activities—crop cultivation and pig-raising—are comparable. Even though crops

and pigs serve different functions--the former fulfils subsistence needs while the latter produces scarce cash income--they both contribute to food security and survival.

When total incomes are organized by the level of local non-farming income, the households which earn more than Y1,000 through these activities have the highest total income (Y11,318), significantly higher than that of the households with less than Y1,000 in non-farming income (Y4,240), or the households with no such income (Y2,346) (Table 6). These households not only have the highest total income; in fact, their income from each farming activity and migration work exceeds those of the other households.

This distinction is not near as clear when the comparison is based on the various levels of migration income. There is no discernible pattern in this case, as households which received no migration income earned the highest total income (Y9,475), which was not significantly different from that of the households with >Y1,000 of migration income (Y8,270) (Table 7). This suggests that the households, which concentrate on building a life locally, fare better on all aspects of their household economy, and that migration does not necessarily lead to the highest economic return. An alternative hypothesis derived from these data is that those with migration income may be benefiting the migrants, but not the family members back home.

The Role of Sweetpotato for Poverty Alleviation

Current Role of Sweetpotato

On average, each of the twenty-eight sampled households in Yilong produces 1.5 tons of sweetpotato a year. For sweetpotato production, most households use organic fertilizer to supplement chemical fertilizer. Organic fertilizer is less commonly used among farmers that are located on the hills because it is difficult to apply the liquid organic fertilizer on the hills. On average, an estimated fifty-three percent of all applied fertilizer is organic.

In general, sweetpotato is harvested during October/November and stored until April/May, with only five percent of estimated loss. Local farmers and extensionists attributed this storage success to the use of *sweetpotato protector*, an herbal storage preserver, by all households while the sweetpotato is stored underground[4]. With these *protectors*, the farmers claim to store sweetpotato for eight to ten months with only one percent of loss with no harmful side effects to either humans or animals.

Six varieties of sweetpotato were observed in Yilong. Shou Di Shao is the most commonly planted variety because it is high-yielding and appropriate for pig feed. Cultivation for human consumption has declined to make way for pig feed. Only eighteen percent of all locally-produced sweetpotatoes are consumed by humans while seventy-five percent are fed to pigs, leaving seven percent for seed. Other than pig feed, sweetpotato has no other local use and the fresh market is limited, even though there is a commonly recognized price (Y.2 kg^{-1}). Only two households were observed processing small amounts of sweetpotato starch, mainly used to cook with pork at home.

Eighty-three percent of the sweetpotato vines are fed to pigs, with small amounts of old vines fed to cattle and some dried stems used as fuel. Most of the vines are chopped and dried, then stored for those days when farmers are too busy to prepare fresh vegetables and grass for pigs, since dried vines do not require further preparation. Silage is not common and only a few

households engage in such a practice. On the whole, there is insufficient vine production, yielding only approximately 4.5 months of pig feed on average.

Sweetpotato-Pig Systems

The current sweetpotato-pig systems in Yilong may be modified to improve their efficiency and potential income. The avenues for improvements include: 1) improving pig growth by augmenting current diet with protein supplement, 2) improving sweetpotato utilization methods, and 3) supporting more pigs on the limited available feed. All three avenues could potentially increase the efficiency of this system and generate greater household income. For example, Thorn (1993) found that the addition of small amounts of protein supplement greatly improved the efficiency and profitability of the smallholder pig production system in the Solomon Islands. Previous research on the effects of sweetpotato as pig feed has shown that dried sweetpotato chips, combined with soybean meal as a protein supplement, proved to be more efficient feed (i.e., lower cost and higher daily weight gain) than fresh roots (Koh et al., 1976). An on-farm pig trial conducted in Vietnam showed that simply balancing the diet improves pig growth while reducing sweetpotato ration and feed cost (Peters, 1998).

Not all methods are appropriate or can be adapted locally. Sweetpotato chips, as promising as they may be, are not an option in Yilong where sweetpotato is harvested during the cold rainy season. However, various locally manufactured protein supplements are widely available. Farmers hesitate to use them because their previous experiences with these supplements have failed to improve pig growth. It is possible that the failure may be due to unbalanced application.

The pig trial in Vietnam (Peters, 1998) achieved higher profit ratio than those of the pig-raising methods in Yilong (Table 8). This feeding method, however, may not lead to similar results in Yilong because: 1) Yilong has a longer and more severe winter, during which pig growth slows down, 2) there are two different races of pigs in the two countries, 3) sweetpotato chips cannot be easily processed in Yilong, and 4) the Vietnam trial raised pigs from about ten kg to sixty-five kg, and it is recognized that pig growth is slower when smaller. However, this still suggests that balancing the diet with small amounts of added protein may greatly improve pig growth in Yilong.

Another potential system is recommended by the Yilong County Livestock Station which produces and sells balanced feed. The recommended feeding period is 173 days on average, and the estimated cost is Y273.8, while producing a total value of Y541, yielding a 1.5 profit ratio (Table 9). This option, however, needs to be verified in a trial since such a practice was not observed and all numbers are based on projections.

Sweetpotato Starch and Noodles

During the 1980's and 1990's sweetpotato starch processing developed on a small-scale in Sichuan Province, with most starch processed into noodles (Tang et al., 1990). It is estimated that, in Sichuan only, five percent of all harvested sweetpotato was processed in the 70s, ten percent in the 80s, increasing to twenty percent in the 90s. However, an estimated forty-five percent of all sweetpotato in China has been processed in the 90s (Li et al., 1992). Small-scale sweetpotato starch and noodle processing has been flourishing in many townships in Neijiang County, Sichuan.

Wheatley (1997) reported increased noodle production in Anyue, a township in Neijiang, from 3,000 tons in 1990 to 25,000 tons in 1996, indicating a rapidly growing market demand. Over sixty percent of all sweetpotato starch and noodle processing is small-scale, representing opportunities for rural income generation through on-farm agro-processing enterprises (Wheatley et al., 1997). This trend has spread throughout many counties in Sichuan, but Yilong has yet to develop the awareness and technology of sweetpotato starch and noodle processing.

Establishing sweetpotato noodle processing, in fact, has been contemplated by Mr. Mo, the most senior sweetpotato noodle wholesaler in the county. He believes that sweetpotato noodles processed in Yilong could be distributed to other nearby counties. However, he has not acted on this idea for three reasons: 1) credit is expensive both from private lenders (three percent a month) and from the bank (1.8% a month); 2) there is insufficient water and high electricity prices (Y1 per Kwatt); and 3) poor road condition may result in costly transportation (this problem has been resolved since the road has been repaired).

According to five sweetpotato noodle wholesalers interviewed, sweetpotato noodle sales vary greatly with season, but the total sales of sweetpotato noodles in Yilong was estimated to be 150 - 200 tons per year. Over the years, the price of sweetpotato noodles has not fluctuated greatly. Instead, the price fluctuates with the season--up to 5 Y/kg in the winter and down to 2.9 Y/kg during the summer. Currently, all sweetpotato noodles come from Neijiang County, a distribution centre of Sichuan's sweetpotato starch and noodles, and they sell for 4 Y/kg, while pea noodles are 7 Y/kg and rice noodles are 3.2 Y/kg. If sweetpotato noodles were produced locally, the price would be even more competitive and stimulate greater demand. However, the director of the Project Office of Yilong has set her long-term goal on producing great quantities of sweetpotato starch and noodles to be distributed in the Chengdu or Neijiang markets, not limited to the local market.

The processing profitability of sweetpotato starch/noodles in Yilong is estimated in Table 10, based on processing data from Santai County, another one of the three major noodle producing counties of Sichuan, but using the prices of fresh roots, electricity, labour costs and starch and noodles in Yilong. The projection examines the costs (variable costs plus fixed cost), total sales (noodle and wet residue), and net profit of a small-scale processing enterprise (mostly manual processing with high labour input and low equipment demand, and low daily output) which yielded 10% root:starch conversion rate and a medium-size processing enterprise (machine processing with low labour input but high equipment demand, and higher daily output) which yielded 13.1% conversion rate. The raw material (fresh roots) accounted for 71-77 percent of variable costs. Labour accounted for the second highest cost (twenty-one percent of total variable cost) for the small-scale enterprise, while electricity accounted for a high cost for the medium-size enterprise due to the quantity and high per-unit price of electricity in Yilong. Even at such high per unit cost, electricity accounted for a very low percentage of the total costs: .02% for the small enterprise and 4.5% for the medium enterprise. The determining factors of profitability were prices of starch and fresh roots.

The net profit from processing one ton of fresh roots into starch for the small enterprise was considerably lower (Y39.8) than that for the medium enterprise (Y155.5) due to a lower conversion rate and higher labour cost. Instead of selling the starch, a processor may continue to process the starch into noodles. Or a specialized noodle processor may purchase starch to process into noodles. Estimates of costs and sales profits from noodles, also based on the study in Santai

County, showed that noodle processing was far more profitable than starch processing, regardless of the size of production (Table 11).

Sweetpotato starch processing also promotes an integrated system in which the processing residue is used as pig-feed. The Centre for Integrated Agricultural Development (1995) reported that it takes three tons of residue to raise a pig, yielding a net profit of Y262[5]. Thus the net profit from processing one ton of sweetpotato totals Y106.8 for small-scale processing and Y210.1 for medium-scale processing (Table 12). A summary of the relative values of one ton of sweetpotato, according to its utilization, shows that modified pig raising, starch and noodle processing are likely to increase incomes (Table 12).

The relative value (net profit from processing plus the labour income) of a household's sweetpotato roots according to their utilization is shown in Figure 5. A household which engages in medium-scale noodle producing would generate Y1139 of net profit from the 1.5 tons of sweetpotato the household produces, plus Y205.83 of labour income. Accordingly, if the household engages in small-scale starch processing, the 1.5 tons of roots would generate Y160 of net profit, plus Y61.56 of labour income. For pig-raising, however, labour is not paid and is not considered an income. Its value appears within the household pig enterprise profit, a total of Y611.9 for the 1.5 tons of sweetpotato. In this case, the alternative use of sweetpotato would increase household income by Y30 to Y1,153, depending on the utilization of these roots (Table 13).

The value of 400,000 tons of sweetpotato produced in Yilong could increase substantially current value, if sweetpotatoes are utilized in a combination of modified pig feeding, and small- or medium-scale starch and noodle processing (Figure 6). Modified pig-raising methods would reduce sweetpotato consumption by pigs by half and re-allocate these roots for processing. Combination 5 (forty percent for pig raising, ten percent for market or consumption, thirty percent for small noodle processing, and thirty percent for medium noodle processing) could potentially generate an extra 292 million yuan, if the current labour inputs of pig-raising are considered costs, or 100 million, if labour inputs are not considered costs.

Migration

Migration Income

Migration income is important and Zhanggong Township[6] received 7 million yuan from its migrants in 1996 (Jiang, Agricultural extension specialist of Zhanggong Township, Pers. Comm.). Divided by the 4,700 households in Zhanggong, this figure means Y1,489 per household of migration income, which accounts for nineteen percent of the total household income. This estimate is comparable to the household interview data in which migration income accounted for seventeen percent of the total household income (Table 5). If the households are categorized by their migration income level, it shows that migration accounts for forty-five percent of the household income for those who receive > Y1,000 of migration income; however, migration accounts for only twenty-eight percent of the household income for those who receive 0 - Y1,000 of migration income. The alternative uses of sweetpotato, on the other hand, could potentially contribute to an additional income increase of .3% to fifty-seven percent (Table 14). This indicates that, for households with moderate migration income, modified pig-raising, and noodle processing could provide additional income comparable to that from migration.

Nevertheless, economics alone does not determine the migration trend, for it only accounts for the "pushing" factor of rural out-migration. The "pulling" factors of urban in-migration also need to be considered to understand what draws people, mostly youth, away from the rural area. Both the push and pull factors must be understood to determine whether alternative sweetpotato utilization could impact migration from this area.

Life of a Migrant Worker

Money and city life constitute attractive pulling effects, but many aspects of a city life can also wear a person down, especially a youth from the rural area with little education, skill, or experience. The migrants' experiences vary across time and space and their stories reveal what pushes and pulls them to come and go. Mr. Lin worked in construction in Dalian building hotels and fancy apartments when he first arrived. Since then, he has become a small contractor, not only providing higher income but also providing opportunities for learning about construction. While back at home collecting his sons to go to Dalian to work with him, he conveyed a business idea for the future, when he would return here to home. His experience taught him that the locally abundant bamboo can be processed into quality construction material, and the income from Dalian would fund the start-up of this business. Needless to say, he considers working in big cities a great opportunity.

This success was in direct contrast with other construction workers. Mr. Deng, for example, did not find construction life in the city very satisfactory.

> *I worked in Guangzhou and Hainan for a few years and life was very difficult. We did hard labour for at least 8 hours a day. If there is no production, there is no pay. We lived in makeshift shacks at the construction site and there were only temporary toilets. We moved from one construction site to another.*

Mr. Tang's son's experience was similar to Mr. Deng's. Mr. Tang said that his son had often been cheated and not paid for his work, and consequently, he had not sent home any money. In these cases, not only the migrants do not bring home money, they lose the money invested in transportation and room and board in the city.

> Despite the individual experiences, the job market seems to be tighter. Mr. Liu said: *More and more people leave the country to look for work in the cities and work is getting difficult to find. I have four children and a daughter-in-law working all over the country. In the past, I received Y5,000 a year, but this year I received nothing.*
>
> This coincides with Ms. Bai's statement:
>
> *I came home to assist my mother-in-law on the farm because she is often sick and to look after my child who is four. It was also difficult to find money or work in Hainan this year. It was much easier in the past when my husband and I could make Y4-5,000 a year. But we only made Y2,000 since last year.*

Leaving her three children at the farm, Ms. He went to work in a shoe factory in Guangzhou a few years ago and had recently returned to the farm. She was able to make some money at the factory, but the conditions were rather strenuous.

> *I worked in Guangzhou in a shoe factory because my husband's three brothers all worked there. It is better to be home taking care of the children. We lived in the factory dorm and paid Y30 a month for rent and utilities. Each room had fifty to sixty people in it and each got a bed. Food was served for Y3 a day. After the rent and food, we made Y200 a month. We worked 12 hours a day, seven days a week. We did get two or three days off a year for national holidays. For twelve hours we sat there and sewed shoes. I got along fine there because most of the workers and my dormmates were from Sichuan. I enjoyed it when I was there, but now that I am back, I don't like it at all anymore. I don't want to go back anymore.*

Whether money is made or not, the living conditions can be tough. Ms. Bai who worked as a hospital janitor in Hainan, was crammed into extremely crowded quarters:

> *Our room in the hospital was next to the trash pile, and six and seven people lived in it. The room was just big enough for three hospital's single beds and each slept two.*

Sometimes getting there and going home can be a painful experience, as Mr. Liu told of his experience of taking a hard seat on a chartered bus to Beijing for three days and three nights. Ms. Huang, with a worse experience on the road, was robbed when the driver pulled off the road at night to allow conspired bandits to threaten the passengers with knives. Having been warned before the trip, she kept a small amount of money in her pocket to hand out. She also conveyed that raiding migrant workers' dorms and robbing them on the streets on pay-days were common occurrences.

These phenomena can also be understood from the perspective of those who are left behind to tend the farm. Ms. Xu, the wife of a migrant worker, shed more light on the implications of this rural exodus on the remaining rural population.

> *My husband has been working in Guangzhou for six years. He left for Guangzhou three or four months after we got married. He comes home once a year for the Spring Festival. Each year he brings home about Y2,300, but says life is difficult out there. But he does not like farming anymore either. So, he does not want to stay here. I don't know where he is in Guangzhou because he moves around with construction. He has no address. He likes to be out there, but when things get tough he wants to come back. But when he is here, he is bored with farm life. It doesn't matter that he is not here. We need the money and it is good that he brings home the money.*

The exodus of the young and the strong leaves the rural area with the old tending small children and labouring over the farm. An old lady carrying a child on her back while dragging another two on the way home from the field is a common sight, as she is left with the responsibility of caring for both the son's and daughter's children while farming their land.

Several informants agreed that life back at the farm is much better with greater flexibility and varied activities, unlike the monotonous and repetitious work in the city, but concluded that they would like to go back to the city for various reasons. A shortage of local work opportunities, farming or non-farming, is a push factor. A steady monthly income, albeit small and often with social sacrifices, is an attractive pull factor. The situation of migrant labour can be summed up by Ms. Dong, who also worked in a shoe factory in Guangzhou: "it is hard work in the factory, but the work on the farm is just as hard, if not more physically demanding. At least I make more money in the factory than staying on the farm."

The migrants' and their family's stories revealed that lack of rural opportunity (i.e., farmland too small for all members of the household and lack of non-farming employment) was indeed the driving force of out-migration. Even though there are success stories, they seem to be few and far between. The monotonous factory work, the transient lifestyle of construction work, the miserable living conditions, the strenuous work schedule, the harsh bus and train rides, the danger of robbery, and the uncertain employment situation all contribute to a sense of disillusionment. Nevertheless, the feeling of resignation is also strong: "we will overcome any difficult obstacle for the steady income in the city."

Conclusions

The substantial sweetpotato production in Yilong County has, so far, not reached its potential contribution to household economy. As the rural population of Yilong leaves their homes and families in search of a more prosperous life, the opportunity for alternative sweetpotato utilization has been ignored. With the economic boom in China, there is a growing market for pork and sweetpotato noodles in China, and obviously sweetpotato must play a crucial role in fulfilling that demand. In order to take advantage of the market, however, the current sweetpotato-pig system must be modified and improved through on-farm pig-feeding trials, and sweetpotato starch and noodle processing must be introduced and refined through on-site research. Whether sweetpotato post-harvest utilization can retard or even reverse the trend of migration will depend on both sufficiently addressing the technical inputs as well as the social aspects of technology transfer.

The pig trial conducted in Vietnam can only be used as a reference point for comparison with the current practice, but it cannot be directly transferred or applied to Yilong, due to socio-economic, agronomic, and marketing differences. On-farm trials that are appropriate for the local conditions are essential in determining the most efficient method of improving the sweetpotato-pig system in Yilong. The challenge with regard to finding ways to improve pig growth does not lie in the shortage of available commercial protein supplement, but rather in determining which supplements, out of an array of commercial products, are palatable to pigs and are cost-effective when combined with the traditional local feed sources. This challenge can only be addressed by carefully designed on-farm trials rooted in traditional practices with affordable and practical modifications. On-farm trials also simultaneously define and transfer technology to a wide rural

population, especially when followed up with extension meetings upon completion of the trials (Peters, 1998).

The market potential of sweetpotato starch/noodles is growing rapidly and the estimated demand for noodles in Sichuan alone is 300,000 tons (Zhang Xiaoyun, Pers. Comm.), which can easily absorb the 20,000 tons that could be processed from fifty percent of the 400,000 tons of fresh roots produced in Yilong. The overwhelming task is to produce an acceptable quality of starch and noodles and to organize the production to be marketed in Neijiang or Santai. The immediate research need is to determine the agro-enterprises development strategy within the Yilong socio-economic context. Concurrently, on-farm trials must be organized to work with small- and medium- size enterprises to find ways to improve starch and noodle quality so that they may become competitive in the market. Market studies are also needed to define strategies for marketing the starch and noodles both locally and outside the county.

As has been demonstrated earlier, modified sweetpotato-pig systems and starch/noodle processing will yield considerably more income from the sweetpotato production in Yilong than the current utilization. If the Yilong rural residents fully utilize the fresh roots for these activities, the potential income generated may be comparable to the current income generated from migrant labour. Considering the increasing competition for employment, reduced income opportunities, and the general harsh quality of life of migrants in cities, sweetpotato processing may provide an attractive alternative. The implementation of such an ambitious program, however, would require integrated socio-economic and technical research, as well as integrated research, extension, and development activities.

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[1] Exchange rate: 8.2 yuan (y) = US$ 1.00.
[2] These values are based on the market prices during the harvest season, even though some of the crops were not sold but kept at home for consumption or pig feed.
[3] There is generally little air circulation in these houses: there is no windows in the living room while windows in the rest of the rooms are small enough to prevent the smallest thief from entering through the window.
[4] Only seven percent of the households store sweetpotato in a hillside cave instead of underground.
[5] The profit reported by CIAD was Y314, not including labour as a cost. The net profit decreases to Y262 when labour is included.
[6] Zhaonggong Township was where much of the interview data were obtained.