Fertilizer and Irrigation in Improving Smallholder Food Security: The Case of One Village in Central Zambia

Shiro Kodamaya *

Abstract This paper discusses the development of dry season irrigation farming in the village. I first reviews government agricultural policies in Zambia since the 1960s, which have substantially influenced farming in the village. And then I sheds new light on the ongoing discussion on the positive effects of irrigation systems on the use of improved maize seeds and fertilizer. “Green Revolution” types of innovations have been partially realized in the village, but that have expanded income disparities among farmers. Consequently, farmers’ reliance on subsidized inputs has increased, which has brought about a new type of vulnerability.

Keywords Irrigation farming, Green revolution, Zambia, vulnerability, smallholder

1. Introduction

The paper explores how a Green Revolution type of agricultural innovation such as the use of chemical fertilizers and the development of small-scale irrigation is effective in improving smallholder household food security in Zambia. While utilization of this innovation has been limited in small-scale farming, it is indispensable for the country’s food security and agricultural development.

The paper takes the case of a village in central Zambia where the majority of farmers practice small-scale irrigation farming in the dry season, together with upland maize farming in the rainy season. Farming in the village is a combination of different types: rainfed and irrigated; upland farming and wetlands gardening; maize farming and vegetable growing; subsistence farming and production for the market; and crop production and livestock rearing. In this context, small farmer household food security is not a simple function of staple food production and consumption, but it should be set in groups of different farming activities. Furthermore, small farmers engage in non-farming activities which also affect the food security of their households. The paper aims to explore how policies to support the use of chemical fertilizer and irrigation development for small-scale farmers can affect the household food security of these people in the context of multi-component farming. It will illustrate how access to fertilizer and irrigation influences different components of small farming.

*Hitotsubashi University
1.1 Household food security of small-scale farmers

The food security of small-scale farmers is basically dependent on their ability to produce sufficient amounts of food crops in their fields for their own consumption (subsistence farming). However, other farm and non-farm activities can contribute to food security by providing sources of purchasing food. Those farmers who do not produce enough for subsistence can purchase food. The sources of income to purchase food include off-farm work, sales of natural or processed products, and remittances (UN Millennium Project 2005: 153). One can add cash crop production as a source of income to purchase food. Cash crop production and non-farm activities can also contribute to improvement in household food security through providing sources of income to purchase inputs for food production such as seeds and fertilizer.

The paper focuses on the importance of farm and non-farm activities which can affect household food security by providing income sources for two functions: to purchase food for consumption and inputs for food production.

1.2 Multiple farming components and the market, policy and ecological environment

Smallholder livelihood activities are composed of multiple farming and non-farming activities. Traditionally, people utilized natural resources in multiple ways such as farming (crop cultivation), livestock rearing, and hunting and gathering, and one of the functions of this multiplicity was risk aversion under ecological uncertainties, which made their livelihood resilient. While tendencies to specialize on one activity exist in the present day context, factors such as integration of rural areas into national and global economies and politics, the development of a market economy, urbanization and migration, and development interventions of government and non-governmental organizations have contributed to new activities. These include production for the market; farming with modern inputs such as hybrid seeds, chemical fertilizer and irrigation; and non-farm economic activities such as trading in agricultural produce, and employment in urban centers.

1.3 Improved seeds and fertilizer

A Green Revolution type of agricultural innovation combining the use of chemical fertilizers and improved varieties of seeds on the one hand, and the development of irrigation on the other, contributed to the increased food production and improved food security in many countries of Asia and Latin America. However, it has had limited impact on small-scale farmers in sub-Saharan Africa. In Asian countries the Green Revolution was regarded as making a significant contribution to sustained yield growth, but experience in Africa was mixed in terms of raising rural incomes and lowering rural vulnerability (Ellis et al. 2009: 34).

One explanation for the differences in performance may be the lack of an irrigation development component in African agricultural innovations. In African countries including Zambia, the policy to propagate the improved seeds and fertilizer technology among small-scale farmers was promoted without the development of small-scale irrigation. It might be the case that sustained yield growth from increased use of
improved seeds and fertilizer has not materialized in Africa because it often resulted in crop failure under the unstable and unpredictable conditions of rainfed agriculture.

1.4 Irrigation

Scholars and development practitioners advocate irrigation as an important means to achieve increased agricultural production and food security in Africa. In a region such as sub-Saharan Africa where droughts are prevalent, irrigation could be a key factor in enhancing food security. In the publication *African Environment Outlook*, it is argued that rapidly increasing the area under irrigation, especially small-scale irrigation, will provide farmers with opportunities to raise output on a sustainable basis (UNEP 2006: 84–5). Irrigation (mainly small-scale) is advocated as an example of “sustainable intensification” of agriculture in southern Africa, where agricultural growth depends upon intensification rather than “extensification” (FFSSA 2004: 68). Thus irrigation is considered to be “sustainable” and contribute to poverty reduction among small farmers.

2. History of Rainfed Maize Production with Improved Seeds and Fertilizers in Zambia

2.1 1960s to 1980s: state guaranteed market and diffusion of maize production

At the time of Independence in 1964 Zambia inherited an economy heavily dependent on copper-mining that contributed to 90% of the total exports. The agriculture sector had the dual structure composed of a small number of large-scale commercial farms and a large number of small-scale farms that were engaged in subsistence farming. Since Independence, development of maize farming by small-scale farmers—the majority of the rural inhabitants—was the centerpiece of the agricultural and rural development of Zambia. The government promoted improved maize seed varieties and chemical fertilizers among small-scale farmers. In the period of Kaunda-UNIP rule from the 1960s to 1980s, government policies to support maize production with hybrid seeds/chemical fertilizer technologies among small-scale farmers included marketing, and policies to subsidize both producer and fertilizer prices. The development of irrigation was not integrated into the package of improved seeds/fertilizer technologies which aimed to enhance maize production and productivity. Consequently, small-scale farming remained reliant on rainfed maize production, which was vulnerable to weather conditions such as droughts and rainfall patterns. During the period of the Second Republic, marketing boards such as the Namboard, and cooperatives provided a guaranteed market, purchasing maize at a fixed pan-territorial price (Dorosh et al. 2010: 186).

In the 1970s and 1980s government support for maize production among small-scale farmers resulted in increased maize production as well as spatial diffusion of marketed production of maize toward remote areas. Government initiatives, including price and marketing support, resulted in increased government expenditure on subsidies. By the 1980s structural adjustment programs made continued expenditures on subsidies for maize production difficult, and then unsustainable (Howard & Mungoma 1997: 45).
Lack of diffusion of irrigation among small-scale farmers could have undermined the effects of high yielding varieties and chemical fertilizers on increased production and productivity. The adoption of high-yielding varieties and chemical fertilizers failed to achieve stable food production and increased productivity due to weather conditions such as drought.

2.2 Liberalization of maize marketing and input distribution: 1990s.

After the 1991 multi-party general election, President Chiluba and the Movement for Multi-party Democracy (MMD) came to power. This government implemented economic liberalization and de-regulation policies. Economic stagnation continued, with the deterioration of formal sector employment due to economic liberalization policies.

Following the 1991 election, the government embarked on agricultural policy reforms as part of the structural adjustment programs. The main change in agricultural policy entailed liberalization of the maize price and marketing. Although the Zambian government liberalized marketing of agricultural produce, with regard to agricultural inputs government continued its involvement in marketing through various programs.

2.3 Input subsidies: 2000s

In 2001 President Mwanawasa’s government came to power with a slogan of New Deal seeking to fight poverty and corruption. President Mwanawasa stressed the importance of agriculture in his vision of agriculture-centered development (Zambia 2002b). The Zambian economy recovered and grew, thanks to a series of events such as increased copper production since 2000, surging copper prices in the world market since 2004, and cancellations of external debt in 2005.

The prescriptions for structural adjustments that donors have imposed on Africa led to the elimination of fertilizer subsidies in the 1990s. However, fertilizer subsidies attracted renewed attention in Africa in the 2000s with arguments in favor of using input subsidies as a way of stimulating increased agricultural productivity growth or achieving welfare goals (Morris et al. 2007: 113). Zambia has re-established national fertilizer subsidies (the Fertilizer Support Program, FSP), as well as introducing an input package scheme (the Food Security Pack) specifically aimed at farmers who are too poor to purchase fertilizer, even at subsidized prices (Ellis et al. 2009: 33). In 2002, the Government of Zambia initiated FSP, which aimed to improve viable resource access to agricultural inputs by poor smallholder farmers organized in cooperatives (FFSSA n.d.). Instead of providing fertilizer through agricultural credit, FSP was to subsidize fertilizer purchases by farmers’ groups.

In 2009/2010, 292,662 FSP beneficiaries purchased 69,100 tons of fertilizer, compared with 350,935 farmers who purchased 94,028 tons of fertilizers through commercial purchases (FSRP/ACF & MACO/Policy and Planning Department 2010). Thus, FSP contributed 40-50% of fertilizer distribution.

A review of the FSP (ZACF 2009), led by senior civil servants in the ministries of the Zambian government, noted a number of concerns about the past performance of the FSP, which included:

Poor targeting of farmers (beneficiaries);
Impact on household and national food security
(because of weak monitoring mechanisms, it was not easy to measure the FSP impact);

[Negative] effect on private sector investment and participation (a limited number of fertilizer companies have been able to participate);

[Concerns on] the program’s long-term sustainability; and

Policy inconsistencies (especially with regards to level of subsidy and farmer graduation).

(ZACF 2009: 6; Gould 2010: 136)

2.4 Promotion of irrigation farming

In Zambia irrigation development policies were formulated and implemented independently of improved seeds/fertilizer technologies for maize. Under rainfed agriculture, the seeds/fertilizer technologies require complementary circumstances to reduce vulnerability, particularly because the amount and pattern of rainfall must be favorable for crop growth and maturation (Ellis et al. 2009: 33). When events are not so favorable, input (fertilizer/seeds) subsidies are an expensive way to fund crop failure (Ellis et al. 2009).

The PRSP (Poverty Reduction Strategy Paper) of 2002–2004 has stated that the expansion of irrigation would not only improve food security but would also help reduce poverty (Zambia 2002a: 91). The Fifth National Development Plan 2006–2010 (FNDP) set a target of doubling the acreage under irrigation to 200,000 ha by 2010 (Zambia 2006: 49). The National Irrigation Plan (NIP), formulated in 2005, proposed a strategy for efficient and sustainable exploitation of water resources by promoting irrigation. As an intervention to improve the policy and legal environment, the NIP proposes a reduction in energy and irrigation equipment costs and improved incentives for investing in irrigation.

According to the Food and Agriculture Organization (FAO) of the United Nations, about 100,000 ha were estimated to be under so-called traditional irrigation in 1992 (Daka 2006). These wetlands and *dambo* (low-lying, shallow wetlands) in traditional areas of land tenure have been used for rice, fruit, and vegetable production.

There have been several programs promoting small-scale irrigation that were supported by the government, non-governmental organizations (NGOs) and donors. NGOs have played a particularly important role in mobilizing traditional farmers and emergent farmers to adopt irrigation practices (Daka 2006).

3. Agriculture in Village C

3.1 Research site

The study area is a village in Chibombo District of Zambia’s Central Province. Recently, field research was carried out in August 2009 and December 2010 when at each round of research 16 and 13 household heads or their wives were interviewed to collect data on such items as harvests of maize and other crops, and consumption and sales of maize. The households interviewed were not selected following the random sampling procedure, and as such, they are not statistically representative sample.

The village studied (hereafter called “Village C”) was established in the mid-1970s. The location was previously covered with forest, which was gradually cleared for villages as people migrated into and settled in the area. Village C included approximately 120 households by the
mid-1990s, and 150 households with a population of 1,300 in 2010.

Maize continues to be the most important cash crop as well as food crop for the majority of small farmers in Zambia. While maize is an important crop in Village C, vegetable production is one of the main farming activities. The area around the village is abundant in dambo, which are utilized by farmers for growing crops such as tomatoes, watermelons, and rape. In Village C many farmers combine rainfed farming in the uplands with irrigation farming in dambo, with the latter being conducted mainly in the dry season. In the early 1990s when we first conducted field research in the village, around half of the farmers there utilized dambo for vegetable production (Hanzawa 1995).

Both farming activities can be complementary in two respects. First, dambo gardening is a dry-season activity that does not compete for labor and land with upland farming and other activities. Second, the two activities can be interconnected in such a way that the revenues from vegetable sales are used for purchasing maize production inputs for the rainy season. Combining both types can provide farmers with the basis for more stability in income and farming by increasing the resistance to various shocks emanating from weather changes and market fluctuations. Practicing two different types of farming can contribute to stability in food availability and income of a farming household by increasing the sources of food and income.

However, rainfed maize farming and vegetable growing can both face a different set of climatic uncertainties (related to environmental shocks) and market uncertainties (related to market and policy shocks). Even after the liberalization of maize marketing system, the maize price fluctuations were more predictable than those of vegetables. In contrast, while vegetable production in dambo land is more drought-resistant than upland cultivation, farmers are faced with volatile prices at vegetable markets. This makes revenues realized from vegetable growing less predictable. Since vegetables are perishable, and given the lack of cold storage facilities, vegetable growers face the risk of being forced to sell their produce at giveaway prices or see their crops rotting away in their gardens.

Both rainfed maize farming and irrigated dambo farming demand resources and inputs to gain higher production and productivity. In addition to land and labor, cattle and implements such as ploughs are required to cultivate land. In the Central Province as well as in the Southern and Eastern Provinces, maize and other major crops are cultivated using ox-drawn ploughs. For dambo farming, if one wants to expand vegetable cultivation or the stable irrigated production of crops, equipment such as treadle and engine pumps, are required.

4. The Development of Irrigation Farming in Village C

4.1 Bucket irrigation in seepage zones of dambo

While government policies to promote small-scale irrigation started to develop only after the 2000s, farmers in the areas of Village C practiced irrigated vegetable production in the dry season before the 2000s, when most of them depended
upon bucket irrigation. Since the plots of crops are located in dambo, and the system does not accompany any development of specific plots for irrigation and furrows, water control is limited. As such, the plots were often flooded and crops damaged by floods when the rainy season started. This type of irrigation places some limits on the duration and areas of cropping, which is confined to the mid-period of the dry season when the land surface becomes dry without flooding, and is restricted in area to the low wetlands.

4.2 Treadle pumps and plot development

Irrigation farming in Village C entered a new stage with the start of the new millennium. In 2001 an NGO came to the village and organized some farmers into a group to initiate a small-scale irrigation project. The NGO introduced a new irrigation method utilizing treadle pumps and specific plots with furrows for irrigation. It extended credit for farmers to buy treadle pumps, and trained them in irrigation management and treadle pump operation and maintenance.

The introduction of the treadle pumps had some important social and economic implications in the village. Those farmers who were assisted by the NGO obtained a material and technological base for modern irrigation farming, as they acquired a treadle pump and were trained in plot development and irrigation methods. Thanks to the credit, the farmers were able to get pumps which could contribute to the expansion of their irrigation farming. The new irrigation method entailed a plot development for irrigation which enabled effective water control, leading to more stable production. Treadle pump irrigation enabled expansion of irrigation farming of the project member farmers and contributed to their material accumulation, while non-project member farmers were left out of the development and accumulation.

4.3 Engine pumps

Another development in irrigation methods in Village C occurred around 2005, when a growing number of farmers began to purchase engine pumps. By 2008, about 12 farmers were practicing irrigation farming using these pumps. In fact, many of the engine pump owners were those who had bought treadle pumps in 2001. In other words, there was a shift from treadle to engine pumps among those farmers who practiced pump irrigation. This implied the further development and accumulation in farming by those who first improved their irrigation with the use of treadle pumps. In fact, some of those farmers with engine pumps invested in building a small dike or dam in their land, while others in constructing water tanks or water reserve to pool water for irrigation.

5. Household Food Security in Village C

5.1 Rainfed maize in the uplands

As already noted, farmers in Village C practice rainfed maize cultivation in the uplands, with the majority growing crops in dambo in the dry season. For farmers to obtain staple food — that is, maize — directly, they can grow maize in the uplands, while some grow dry-season irrigated maize in dambo.

One of the most salient features of rainfed maize farming is the volatility of maize production. The field research has found that at household level, harvests from rainfed maize farming in the
uplands fluctuated annually depending mainly on fertilizer availability and weather conditions, but also other factors such as availability of labor and cattle for ploughing.

As shown in Table 1, most of the farmers interviewed experienced fluctuations in upland maize harvests. For most of the years between 2007/2008 and 2009/2010 most of the households were deficient in upland maize, in the sense that the upland maize harvest was less than the amount of maize required to feed the members of the household. While 13 out of 14 households interviewed were deficient in maize (maize production in dambo was not included in calculation) in 2007/08, 13 out of 17 sample households in 2008/09 were deficient. The 2009/2010 season saw bumper harvests all over Zambia, and also out of 13 sample households of Village C, 7 households recorded maize surplus, although 6 households were maize deficient. Maize harvests at household level fluctuated widely. For instance, maize harvests of Household A ranged from 250 kg in 2008 to 4,300 kg in 2010. Maize harvests of Household P decreased from 500 kg in 2008 to 200 kg in 2009, and increased to 1,610 kg in 2010. Since 750–1,000 kg of maize was estimated to be required for the annual consumption for the household, the harvest of 200 kg in 2009 was not sufficient to feed the family throughout a year. They bought 400 kg of maize with their revenue from vegetable sales.

5.2 Factors causing fluctuations in maize production

The fluctuations in production included both ecological and economic factors among which weather changes (such as flood and drought) and shortages of fertilizer were the two reasons most frequently mentioned by the farmers of the interviewed farmers were concerned.

Some farmers reported declines in maize production in 2009 due to floods. Both drought and excessive rain or flooding affected farm production of the area, depending on the season.

Availability of inputs such as fertilizer and seeds affected maize production. Farmers in Village C had several ways to obtain these. In the mid-1990s, just after the liberalization of maize marketing, some schemes and lending institutions extended agricultural credit and some farmers in Village C obtained this credit. However, many farmers failed to repay because they did not achieve sufficient maize production due to drought or late delivery of fertilizer. Nevertheless, private lending institutions were strict in collecting repayment from farmers, including confiscation of debtors’ assets such as ox-carts and ploughs. After some years of these events, there were few agricultural credits extended in Village C, and the majority of farmers obtained inputs through purchase. Many of those farmers with vegetable production in dambo purchased inputs with revenues from irrigation farming in these lands. Some farmers depended on their relatives in urban areas to buy fertilizer.

Another way to purchase inputs was to apply for government and NGO input support schemes. In 2010 there were three farmers’ groups in the village with access to the government’s FSP. However, they had problems such as late delivery of fertilizers and the small amount of fertilizer provided. While the late delivery of fertilizer was caused by factors at the national level, it
aroused a suspicion among some members who suspected that leaders of their group misappropriated some fertilizer.

Some farmers suffered from lack of livestock, which caused low production of maize. As those farmers without draught animals could plough and plant their fields only after owners of cattle had done theirs, they face delays in planting maize.

<table>
<thead>
<tr>
<th>household</th>
<th>Rainfed upland maize harvests (kg)</th>
<th>maize in dambo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008</td>
<td>2009</td>
</tr>
<tr>
<td>C</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>500</td>
</tr>
<tr>
<td>E</td>
<td>50</td>
<td>500</td>
</tr>
<tr>
<td>F</td>
<td>500</td>
<td>150</td>
</tr>
<tr>
<td>G</td>
<td>1,500</td>
<td>1,500</td>
</tr>
<tr>
<td>H</td>
<td>900</td>
<td>100</td>
</tr>
<tr>
<td>J</td>
<td>0</td>
<td>250</td>
</tr>
<tr>
<td>K</td>
<td>750</td>
<td>1,000</td>
</tr>
<tr>
<td>P</td>
<td>500</td>
<td>200</td>
</tr>
<tr>
<td>A</td>
<td>250</td>
<td>450</td>
</tr>
<tr>
<td>B</td>
<td>3,000</td>
<td>400</td>
</tr>
<tr>
<td>L</td>
<td>1500</td>
<td>5,500</td>
</tr>
<tr>
<td>M</td>
<td>–</td>
<td>1,400</td>
</tr>
<tr>
<td>N</td>
<td>–</td>
<td>3,000</td>
</tr>
<tr>
<td>O</td>
<td>–</td>
<td>500</td>
</tr>
</tbody>
</table>

Note: Cells in light shade indicate that the household was in maize deficits, that is: upland maize harvests were not sufficient to feed the household member.
Cells in deep shade indicate the household was in maize surplus; that is: upland maize harvest was more than required for consumption.
K = kwacha (the Zambian currency).
Mil. = million.
– = no data or data was not collected.
# Unit of green maize is composed of 10 maize cobs.

Shortages of labor affected the farming of some from Village C. A female farmer aged around 60, who lived with her sister, mother, daughter and two grand-children, also faced fluctuation of maize harvests (Household D). She managed to harvest 500 kg (10 bags) of maize in 2009 and 200 kg (4 bags) in 2010, but had no harvest of maize in 2008 because she planted late (in late December).
The household suffered a problem of labor shortages as there was no adult male labor in the household.

Shortages of labor were sometimes caused by sickness of relatives, and resulted in declines in maize production. An interviewed farmer reported that his maize production declined because his brother and sister, who lived in urban areas, became sick and he had to go and attend them (Household C).

As the majority of respondents indicated more than one factor that caused declines in production, it seemed that often several factors combined to cause declines in maize harvests, such as shortage of fertilizer and labor; excessive rain and labor shortage; and lack of fertilizer and cattle.

5.3 Dry season maize

Growing winter maize (dry-season maize) is a new development which began in around 2000, and the number of growers increased during the course of the 2000s, although farmers growing winter maize in dambo are the minority even today. In addition, winter maize is grown not only for home consumption, but is sold as “green maize” (maize cobs) mainly at the urban markets. For instance, household L of Table 1 sold 182 units of green maize out of 200 units harvested. Green maize from dambo can be sold at higher prices than rainfed upland maize sold in May or June. One farming household (Household L) sold 3,500 kg of maize harvested from the uplands at 3.5 million kwacha, whereas sales of green maize from dambo fetched 4.48 million kwacha. While a farmer of Household B sold 7,500 kg (150 bags) of maize harvested from his upland fields which raised 4.5 million kwacha, green maize from dambo raised 15 million kwacha (1,500 units) in 2010 and 8 million kwacha (800 units) in 2009. Green maize from dambo is mainly for sale, but can be consumed as an additional food to supplement home consumption.

5.4 Income sources to purchase food

Some farmers purchased food or fertilizer with the money earned by selling vegetables grown in their dambo gardens, while others made their purchases with off-farm income. The most popular off-farm economic activity was petty trading. In some households, women were engaged in the petty trade of selling vegetables at the roadside market about 5 km away from the village.

As shown in Table 2, sources of money to purchase food or inputs to produce food included selling vegetable and other crops grown in gardens, petty trading and remittances. Household P, when faced with food shortages, bought maize with the money realized by selling vegetables grown in its dambo garden. The households E and H bought maize with money earned by selling watermelons and other vegetable.

Some households were dependent on the remittances of their relatives who lived in urban areas. Households D and F bought maize and fertilizer with the remittances from relatives living in towns. A farmer interviewed depended on her son who lived in an urban area to buy fertilizer for maize production, and maize meal for consumption.

5.5 Irrigation

Irrigated farming can relieve the risks of rainfed maize farming and contribute to improved food security either through food or income smoothing or by financing input purchase for rainfed maize
Table 2  Harvests of maize and strategies to get food (maize)

<table>
<thead>
<tr>
<th>Household</th>
<th>Harvests of rainfed upland maize (kg)</th>
<th>Vegetable grown in <em>dambo</em></th>
<th>Non-farm income such as petty trade</th>
<th>Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2008</td>
<td>2009</td>
<td>2010</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>600</td>
<td>400</td>
<td>500</td>
<td>Tomato sales K40,000 in 2009.</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>500</td>
<td>200</td>
<td>Has a garden but no crops grown in 2008.</td>
</tr>
<tr>
<td>E</td>
<td>50</td>
<td>500</td>
<td>600</td>
<td>No crops grown in 2008 because the household head was busy securing maize</td>
</tr>
<tr>
<td>F</td>
<td>500</td>
<td>150</td>
<td>500</td>
<td>No crops grown in 2008 because the household head was sick.</td>
</tr>
<tr>
<td>G</td>
<td>1,500</td>
<td>1,500 to 2,000</td>
<td>750</td>
<td>K6.4 mil. of watermelons sold in 2010, K0.1 mil. of tomatoes and K0.2 mil. of watermelons in 2008.</td>
</tr>
<tr>
<td>H</td>
<td>900</td>
<td>100</td>
<td>–</td>
<td>Watermelons and tomatoes. K0.52 mil. of watermelons sold in 2008.</td>
</tr>
<tr>
<td>I</td>
<td>0</td>
<td>250</td>
<td>–</td>
<td>Tomatoes and rape</td>
</tr>
<tr>
<td>J</td>
<td>540</td>
<td>450</td>
<td>–</td>
<td>Tomatoes, water melons and rape. Tomato sales K0.25 mil.</td>
</tr>
<tr>
<td>Q</td>
<td>300</td>
<td>500</td>
<td>–</td>
<td><em>Impwa</em>, green pepper and watermelons</td>
</tr>
<tr>
<td>K</td>
<td>750</td>
<td>1,000</td>
<td>750</td>
<td>Green pepper, tomatoes, rape and onions sold in 2010 with a total sales K1.2 mil.</td>
</tr>
<tr>
<td>P</td>
<td>500</td>
<td>200</td>
<td>1,610</td>
<td>Green pepper and cabbage sales K1.9 mil. in 2008.</td>
</tr>
<tr>
<td>A</td>
<td>250</td>
<td>450 to 600</td>
<td>4,300</td>
<td>Tomatoes, water melons. Sales K3 mil.</td>
</tr>
<tr>
<td>B</td>
<td>3,000</td>
<td>400</td>
<td>7,500</td>
<td>Tomatoes, green pepper and butternuts. Sales K1.35 mil. in 2009</td>
</tr>
<tr>
<td>L</td>
<td>1,500</td>
<td>5,500</td>
<td>4,388</td>
<td>Tomatoes, <em>impwa</em></td>
</tr>
</tbody>
</table>

Note: Cells in light shade indicate that the household was in maize deficits, that is: upland maize harvests were not sufficient to feed the household member.
Cells in deep shade indicate the household was in maize surplus; that is: upland maize harvest was more than required for consumption.
K= kwacha (the Zambian currency).
Mil.= million.
= no data or data was not collected.
*Impwa* is a local vegetable that is a type of eggplant.
production. In the case study village, the development of dry-season irrigation farming combined with rainfed maize production contributed to increased income and improved food security. However, irrigation farming has its own vulnerabilities such as price fluctuation and damages by floods and crop disease. In addition, it requires resources to purchase inputs and invest in pumps and development of plots, dams, and water tanks. Relatively well-off farmers can afford such purchases and investment. To reduce the risk of price fluctuations of produce and crop disease, it is useful to grow a variety of crops in irrigated plots. In the mid-1990s crops grown by Village C farmers in their dambo gardens included tomatoes, watermelons and rape. In the course of the 2000s some farmers diversified irrigated farming by introducing new crops such as maize, cabbage, green pepper, okra, and onions.

Those farmers engaged in small-scale irrigated farming often grow just one or two crops, and thus susceptible to damage by floods, insects and pests, and price fluctuations. Vegetable farming is quite input intensive and requires substantial amounts of agrochemicals such as insecticides, fungicides and pesticides. Thus, after deducting the cost of inputs, it is not as profitable as it appears from sales.

6. Differential Vulnerability of Farmers According to Strata

How resistant or vulnerable a farm is to external shocks varies from one farmer to another, and village farmers can be broadly grouped into three strata according to their vulnerability or resilience.

6.1 Most vulnerable stratum of farmers

The most vulnerable stratum of farmers was found in those households who were reliant on rainfed farming and who were with limited resources such as land or labor, which resulted in low and unstable production of maize. Since few of this type own cattle and a plough, they tend to be late in planting maize. Their rainfed maize production was volatile due to several factors including weather changes and shortages of labor and land, and in many years deficits were recorded in maize balance sheets.

Some of these farmers depended on remittances of relatives living in urban areas. The relatives in urban areas buy mealie-meal (ground maize) for farmers to supplement the farm’s maize production and to buy fertilizers and seeds.

6.2 Lower stratum of those households combining rainfed maize in the uplands with irrigated farming in dambo

Although this type of farmers combined two types of farming, the potential gain of the combination was not realized because their rainfed maize production was small scale and unstable, and/or their dambo farming was small scale and not diversified, hence susceptible to loss by price fluctuations or damage by crop disease.

6.3 Upper stratum of farmers combining rainfed maize and dambo farming

A small minority of farmers combined larger scale rainfed farming in the uplands with irrigated farming using engine pumps. These well-off farmers had cattle and could afford to buy fertilizers. They could plough and plant on time and apply fertilizers on their fields. Thus they
could run more stable farming with higher productivity for upland rainfed farming. With regard to *dambo* irrigated land, their farming was more stable and large scale through the use of engine and treadle pumps and improved canals. Since their irrigated farming was more diversified in terms of crops grown, it was more resistant to crop disease and price fluctuations.

7. Conclusion

Food production using a Green Revolution type of innovation was developed in Zambia by using improved seed varieties of maize, the staple food, and chemical fertilizers. This was spread among small farmers by state support in marketing and prices of produce and inputs. Lack of an irrigation component undermined the stability of maize production, while limited supply of agricultural credit and shortages of resources to purchase inputs on the part of small-scale farmers curtailed diffusion of the improved seeds/chemical fertilizer innovations. Input subsidies including FSP and small-scale irrigation could break these constraints. In the case study village, the development of dry-season irrigation farming in *dambo*, and its combination with rainfed maize production, contributed to increased income and improved food security by providing income sources to buy food or food production inputs as well as additional food. This makes combined farming more resistant to shocks and fluctuations. However, irrigation farming has its own vulnerability such as price fluctuations and damage by floods and crop disease, and it requires resources to purchase inputs and invest in pumps and plot development. Although FSP contributed to increased maize production through increases in fertilizer availability and subsidies in its prices, only a minority of farmers in the village had access to it. Only this minority of relatively affluent farmers managed to benefit from combining rainfed maize production with improved inputs, some through subsidies, and irrigation farming with diversified crops and treadle and engine pumps.

(Accepted, 2014.12.18)

References


FSRP/ACF (Food Security Research Project/ Agricultural Consultative Forum) and MACO/Policy and Planning Department 2010 Analysis of the 2009/10 Maize Production Estimate from the Crop Forecast Survey, Lusaka.


小規模農民の食料安全保障を改善する肥料と灌漑農業
——ザンビア中央州の1農村の事例から——

児玉谷 史 朗*  

本稿では化学肥料の使用と灌漑がアフリカの小規模農民の食料安全保障に与える効果について、ザンビア中央部の一つの村を事例として検討した。事例村では、近年注目されている湿地帯を利用した小規模灌漑が行われている。本稿では小規模農民世帯の食料安全保障には、自家消費用の食料作物の生産だけでなく、それ以外の農業活動や非農業活動が食料確保の原資を提供する形で貢献し得る点に注目した。

調査の結果、トウモロコシの生産は気象条件（早魃等）と化学肥料の入手状況に影響されること、灌漑による乾季のトウモロコシ作物は限定的であり、むしろ灌漑による野菜生産、小規模ビジネス、親類からの送金が重要役割を果たしていることが明らかとなった。これらによる現金収入が化学肥料等の購入または食料の購入に使われ、食料安全保障が改善した。

キーワード：灌漑農業、「緑の革命」ザンビア、脆弱性、小規模農民

*一橋大学