An Alternative Cropping System of Smallholders in Malawi: Towards Improved Food Production in Sangadzi Area

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「マラウィにおける食糧増産を目的とした小農的作付け体系に関する一考察
—サンガチ地区を中心に—

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マラウィの農業は大農と小農に分けられる。前者は輸出用作物生産に特化し、後者は自給農業で大多数の国民の食糧を供給する。小農は依然として一期作を中心とした生産性の低い粗放的農業を行っている。ゆえに、近年小農において食糧確保が問題となっている。

上記の研究課題を念頭にサンガチ農業区の実態調査を踏まえた事例分析をおこなったところ、同地区においては1ha未満の農家は自らの食糧を確保できていないことが判明した。彼らの農業生産を取り巻く環境をそのまま放置しておけばこの現状は悪化する一方だと思われる。以上のことを踏まえ、本研究では小農の食

糧生産事情を改善しその自給度を増大させるため、二毛作農業の体系とその可能性について検討した。その際、現地の農業環境、従来の農業、作物・作付けとの連続性ならびに農民の社会経済的状況、肥料・種子等の投入材の購買力、食糧のニーズ等の関係について検討した。その結果、農民的生産要素、農地、家族労働、伝統的知識を最大に活用しうる在来品種のトウモロコシとキャッサヴァの二毛作を軸にした農業が無理なく低コストで小農の食糧の自給度を高めることができることが明らかになった。このような農業を普及させるのがマラウィ農業の今後の課題となる。

1. Introduction

Malawi is a land-locked country in South-East Africa surrounded by Tanzania to the north, Zambia to the west and Mozambique to the south, southwest and east. The size of Malawi is 118,484 km², of which 20% is water, mainly Lake Malawi. Malawi's population is about 11 million and its density is 117 people/km² (World Bank, 2002). More than 85% of the population lives in rural areas, mainly engaging in farming for their livelihood. Malawi's economy is agricultural based. Agricultural sector is bimodal, comprising estate farming and smallholder farming. Estate

agriculture is mainly commercial farming of cash crops such as tobacco, tea, coffee and sugarcane, while smallholder agriculture is mainly subsistence farming and comprises of farmers with small landholdings, usually between 0.5 and 3.0 ha. Agricultural sector contributes more than 34% of Gross Domestic Product, (25% by smallholder sub-sector), 80% of export revenues (70% by estate sub-sector) and serves 90% of the labour force; the majority of agricultural labour comes from the smallholder sub-sector (Malawi Government, 2000). Smallholder agriculture also accounts for over 85% of staple food production while estate agriculture contributes 12% of total agricultural production (*ibid*).

Malawi's smallholder agriculture almost entirely depends on rainfall and comprises of one-season (November–April) and one-harvest cropping systems.

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Productivity in smallholder agriculture is generally low. The smallholder sub-sector is also characterized by rural poverty. About 66.5% of the rural population live below the poverty line¹ of about US\$135 per annum while 54.9% of the urban population are poor (National Economic Council, 2000). More than 70% of smallholders in Malawi have less than 1 ha of farmland (Whiteside and Carr, 1997) and this comprises of the poor majority.

Based on current rural socio-economic conditions and agricultural production, this paper analyses the extent of smallholder food production and household food sufficiency using a case study of Sangadzi area. Assessment of household food sufficiency will be done taking into consideration the options between maize and cassava, the two major food crops in Malawi. The study focuses on smallholder farmers because of the magnitude of their population, low socio-economic status and the extent of food security problems, which they face. Most smallholder households in Malawi use family labour to work on the farms and in households. Therefore, their production decisions and socio-economic status are determined by their own labour and land use on their farms.

2. Study Methodology

The field survey was conducted from August to September 2002 in Sangadzi area north of Mangochi district in the Southern Region of Malawi. Sangadzi area was taken from Mbwadzulu Extension Planning Area (EPA) of Mangochi Rural Development Project (RDP), one of the four RDPs of Machinga Agricultural Development Division (ADD). Sangadzi area was purposefully selected for this study because of its abundant supply of water from Lake Malawi and Sangadzi River in addition to annual rainfall. Sangadzi area has a tropical savannah type of climate and vegetation, with generally sandy-loam soils. It has mean annual temperature of 28°C and receives about 855.4 mm of rainfall annually; Mangochi district receives mean rainfall of 814.6 mm annually (Malawi Government, 1998a). About 90% of rains in Malawi fall between November and March (Reynolds, 2001).

In Sangadzi area, rains start in late November to early December and stop falling in March or early April. However, most places maintain adequate moisture for farming until July, 3 months after harvesting most field crops.

The survey had covered 7 villages with a total of 2,043 farm households. Sampling of farmers was done in a stepwise process using three kinds of purposeful sampling strategies: (1) Stratified purposeful sampling, (2) Maximum variation (heterogeneity) sampling and (3) Purposeful random sampling, as outlined by Patton (2002). A sample of 138 smallholder farm households was randomly selected and orally interviewed with structured questionnaires. Where the use of questionnaire was not feasible, data was collected through participatory rural appraisal (PRA) methods with groups of farmers. The author, with the support of two research assistants from the University of Malawi, collected primary data while all secondary data was collected by the author. In calculating food sufficiency, production figures (kg) of other food crops were converted into maize equivalents (ME, kg) as a standard measure by the formula:
$$ME (kg)_{other\ crop} = \left(\frac{Nutrient\ Energy\ (kcal/kg)_{other\ crop}}{Nutrient\ Energy\ (kcal/kg)_{maize}} \right) \times Production_{other\ crop} (kg);$$
 based on FAO (1997).

3. Smallholder Land use and Cropping Systems

3.1 Availability of Land for Smallholder Farming

Malawi has a total of 5.7 million hectares of potential agricultural land of which 4.6 million hectares are under customary land tenure system, mainly used by smallholder farmers (Ahene, 2001). In smallholder agriculture, rapid population growth has caused a fast decline in available land for farming and an increased pressure from competing demands on the use of land, including the need for food production, firewood, construction materials and communal land. At household level, Malawi has mean household size of 4.4 persons per household; household size in rural areas is 6.3 (NSO 2000). Correspondingly, average landholding in Malawi has declined from 0.7 ha in 1987 to 0.6 ha per household by 1998 (Ahene, 2001). The

trend of landholding shows that by 1997, 72% of smallholders had landholding of less than 1 ha compared to 55.1% in 1985 (Republic of Malawi, 1986; Malawi Government, 1998a). Sangadzi area has average household size of 5.2 persons and average landholding of 1.4 ha per household. Like many parts of Malawi, the land is not evenly distributed, (standard deviation, $SD=0.861$). Only 14.5% of the sample has more than 2 ha of land, while 85.5% have less than 2.0 ha per household. About 34.8% of households have 0.5-1.0 ha, 44.2% have 1.1-2.0 ha, and 2.9% have less than 0.5 ha per household. Reduced farmland negatively impacts on people's socio-economic status and management of land resources by the affected farmers. On resource poor smallholder households, declined farmland has serious challenges on food production and household food sufficiency, as more food must be produced from a small piece of the available land.

3.2 Smallholder Cropping Systems in Malawi

Figure 1 shows an overview of the current farming schedules in smallholder agriculture in Malawi. This schedule is a generalised one based on field experiences between 1999 and 2002 in various parts of Malawi and during the survey period in Mbwadzulu EPA. Obviously, minor location specific differences exist which at times affect farm management and

production. However, this study focuses on the general outlook of smallholder food production and household food sufficiency under land constraints and low productivity. The land husbandry activities such as land preparation; ploughing, ridging, planting, weeding, fertiliser or manure application and harvesting are scale neutral in terms of farm size. They are undertaken similarly on bigger and smaller farms within smallholder agriculture in Malawi.

The principal smallholder crops in Malawi are maize, rice, sorghum, millet (*Eleusine coracana*), cassava, sweet potatoes, Irish potatoes, groundnuts, and pulses, tobacco and cotton. Groundnuts, pulses, tobacco and cotton are the major smallholder cash crops mainly grown by farmers with at least 2 ha or more, while maize, cassava, potatoes, rice, sorghum and millet are the basic food crops consumed in different parts of Malawi. Some of the basic food crops are area specific while maize the staple food crop of Malawi is consumed all over the country.

Generally, land preparation and ridging are done between late August and November and planting takes place depending on first rains but basically, from late November to January, followed by weeding through March. Harvesting is expected in April or early May. Cropping schedules are mainly characterized by intercropping of maize or other location specific major

Time Period	Almost dry period			Rainy Season (Rainfall: 750 - 1043 mm per annum)								Spring Moisture (Amount not recorded)			
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug			
Activity 1 (General)	Land preparation, ploughing and ridging.			Planting, Weeding and Fertiliser application, Banking (heaping the ridges). Tethering goats and sheep.					Harvesting (in general) Free-range livestock.						
Activity 2 (Specific)				Planting maize, groundnuts, cotton, tobacco, millet, sorghum Irish potatoes and ground beans. Intercropping with legumes Weeding, Banking all cropped ridges. Fertiliser application.		Planting and weeding cassava, sweet potatoes and rice and the intercrops.		Harvesting, tobacco, pumpkins, okra, cowpeas and local peas. Sequential cropping of cowpeas, local peas and beans.		Harvesting maize, groundnuts, cotton, millet, sorghum and legumes.		Harvesting of cassava begins, rice, sweet potatoes, late maturing legumes.			
Activity 3 (Specific)	Free-range livestock; harvesting cassava, legumes continue.			Harvesting of cassava (continued). Planting new cassava on the harvested plots (Activity crosses over to next farming calendar).											

Figure 1. Smallholder farming schedule in Malawi

Source: Field survey (1999 and 2002); Rainfall data by Malawi Government (1998a).

crops like sorghum or millet, with a number of minor crops mainly the legumes. Most of the minor crops serve as a side dish and contribute to household nutrition and sometimes as a basic source of cash income. The commonest forms of intercropping in Sangadzi area are maize with pigeon peas, maize with dolicos beans and maize with velvet beans. Most major crops are grown on separate farm plots and intercropped with some minor crops whenever possible. Cassava, sweet potatoes and rice are harvested between May and September depending on variety and purpose.

Smallholder cropping systems in Malawi are almost similar to those practiced by farmers in the whole African savannah to which Malawi belongs. Traditional rain fed cropping systems throughout the arid and sub-arid zones are mainly based on pearl millet on the lighter sandy soils and sorghum on the heavier soils, often with cowpeas intercropped (Ker, 1995). Ker (1995) further notes: farmers plant a range of varieties of these crops for particular purposes and in different micro-ecological habitats. They generally have strong reasons for their choices as their survival depends on them. Increasing pressure of both population and livestock throughout these zones are causing severe stresses to the cropping systems. In some areas that have long been heavily populated, such as northern Nigeria, the permanent cultivation systems that enable continuous cropping have been described. Cash crops in the form of groundnuts (mainly in West Africa) and cotton are also grown in the sub-arid and sub-humid zones, maize is replacing some of the sorghum, and rice is becoming more widely grown in swamps and irrigation schemes. In the sub-humid zone, a wide range of other crops, including sweet potato, cassava, sesame, pigeonpea, and many fruits and vegetables, are also cultivated, usually in mixtures. There is evidence that mixed cropping can increase both the net value of the production and the net return to labour (Ker, 1995). In areas with highly unreliable rainfall, agriculture is often very risky and mixed cropping may help as a survival strategy. As Meertens, et.al (1995) notes: Wasukuma farmers

practice mixed cropping and intercropping as risk reduction strategies; the basic mixtures are grains especially, maize with legumes like cowpeas, green gram, beans and groundnuts. These strategies are similar to those followed by farmers of Sangadzi area.

Smallholders also possess livestock mainly poultry and small ruminants, such as goats and sheep. Generally, smallholder livestock herds are raised on free-range feeding system with little or no supplementary feeding. Smallholder livestock are mainly raised for food (meat, milk and eggs), some cash income and for traditional ceremonial functions such as weddings (paying *lobola* or dowry) and for initiation ceremonies. In most African savannah countries, livestock ownership is variable, but a high proportion of farmers keep a few goats or sheep, perhaps averaging about 2–6 animals/farm, and some poultry (Ker, 1995). Livestock are not usually closely integrated into the farming system, being mainly grazed on communal grazing lands. They may graze stubbles and other crop residues after harvest. Livestock throughout Africa are generally kept on an extensive basis. In addition to providing some meat, milk, and hides, they often seem to be valued mainly as a way of saving money or as an insurance policy; a “bank on the hoof” (Ker, 1995). Observed by Steinfeld (1988), traditional livestock systems in Africa rarely serve only a single purpose such as the provision of meat; it is common to rear livestock for multiple uses, which apart from meat and milk include the provision of transport, draught and manure. Apart from these attributes, livestock have an asset and security function and play an important cultural role in many traditional African societies. Like most parts of the country, in Sangadzi area goats and sheep are raised on free-range grazing system and tethered during the cropping (rainy) season in order to prevent them from damaging field crops.

Almost all smallholder farmers in Malawi grow maize. Maize is grown on more than 75% of the annually cultivated land (Malawi Government/UNICEF, 1996). However, almost 80% of the maize land is cultivated with local maize despite being low yielding,

and about 19% of the maize land is cultivated with hybrid maize (Malawi Government, 1998a), which yields highest among the maize varieties in Malawi. Only about 1% of the maize land is planted with composite varieties. Reasons for low adoption of hybrid maize include generally the high cost of hybrids. Hybrids require yearly purchase of seed and chemical fertilizer for high production. However, due to poverty, most smallholders cannot afford chemical fertilizer hence, they continue using low yielding local maize seed. On the other hand, smallholders do not adopt composite varieties because although they yield higher than local varieties, they are easily damaged by storage pests and do not pound well in local mortars. Another reason for low adoption of hybrid maize is that yields of hybrid maize greatly fluctuate across seasons far more than those of composites and local maize varieties. Thus, hybrid maize has higher probability of risk in times of natural disaster than local maize, which adapts well to local agro-ecological changes. Therefore, to avoid total loss, most smallholders plant local maize varieties.

4. Case Study of Sangadzi Area

4.1 Crop Production in Sangadzi Area

In Sangadzi area smallholder farming is generally closely linked with occurrence of natural events. Basically, the smallholder farmers observe flowering of some natural trees and shrubs to guide them in land preparation as the saying goes: "when the baobab tree starts leafing/flowering, it means rainfall will soon start." This study observed that about 50% of the farmers in Sangadzi area prepare their land by October when the baobab tree and some natural shrubs are flowering. In terms of land use, this study found that maize, cassava and sweet potatoes, are the major cultivated crops in Sangadzi area. From a total of 184.5 ha of cultivated farmland in the year 2002, maize took up 61% of the cultivated land. Almost 75% of maize land was planted with local maize varieties. Cassava was planted on 12% of the cultivated land while sweet potatoes took up 8%. Other common crops include groundnuts, cotton, rice, pigeon peas,

tobacco, and various local beans grown as intercrops, including millet, ground beans, sorghum, dolicos beans, and cowpeas. There is low adoption of hybrid maize varieties in Sangadzi area. About 88% of the households had grown local maize while 38% had grown both hybrid maize varieties and local maize, but on separate farm plots. The reasons for low adoption of hybrid maize were similar to those already discussed in the previous section. In addition, lack of hybrid seed affects wide adoption of hybrid maize by farmers of Sangadzi area. In Sangadzi area cassava and sweet potatoes are mainly grown because these two crops are drought tolerant and can serve as an insurance against failure of maize production. Cassava also serves as alternative food to maize and is used as a form of payment for farm labour during peak periods of labour (December-February); the same time when the country faces critical food shortages (Malawi Government, 1998b).

In 2002, Sangadzi farmers had produced a total of 180.388 tons of which 171.388 tons (95%) were total foodstuffs and 155.447 tons (91%) were basic foodstuffs such as maize, cassava, sweet potatoes and rice. In maize equivalents (ME), total basic food production in Sangadzi area was 133.339 tons. Maize had contributed 72.337 tons (54% of basic foodstuffs, with 33% from local maize and 21% from hybrid maize). Cassava had produced 45.963 tons ME (35% of basic food); sweet potatoes had produced 8.051 tons ME (6% of basic food) and 6.988 tons ME (5% of basic food) came from rice production. These results give a general picture without considering differences in landholding amongst the households. Based on landholding per household, the food production situation was as shown in Table 1.

It was found that farmers with less than 0.5 ha obtained the highest yields of local maize both in Sangadzi and at national level. No farmer in this land category had planted hybrid maize and other basic food crops. However, it was observed that intercropping local maize with pigeon peas, pumpkins, okra and many other local beans was most prominent in this landholding category (of less than 0.5 ha). Yields of

Table 1. Production of basic foodstuffs according to landholding in Sangadzi, compared with National level, 2002

Crop	Local maize	Hybrid maize	Maize Total	Cassava	Sweet potato	Rice	Mean landholding (ha)
Production (kg)							
Sangadzi area							
< 0.5 ha	1,100	-	1,100	-	-	-	0.40
0.5-1.0 ha	14,597	5,530	20,127	13,800	7,200	800	0.74
1.1-2.0 ha	18,570	9,600	28,170	23,205	13,630	4,000	1.50
2.1-3.0 ha	5,380	3,670	9,050	5,800	6,100	975	2.49
> 3.0 ha	4,960	8,930	13,890	5,600	800	1,200	5.20
National	556,359	639,321	1,195,680	3,105,389	2,599,279	94,187	-
Yield (kg/ha)							
Sangadzi area							
< 0.5 ha	688	-	-	-	-	-	0.40
0.5-1.0 ha	637	1,177	729	2,262	2,156	1,600	0.74
1.1-2.0 ha	485	722	546	2,275	2,253	1,538	1.50
2.1-3.0 ha	572	706	620	2,636	1,605	1,083	2.49
> 3.0 ha	420	2,030	857	2,947	2,000	1,500	5.20
National	669	1,717	993	14,728*	12,524*	1,668	-

Source: Field survey (2002); Malawi Government (2002).

Note: In 2002 yields for cassava and sweet potatoes are extraordinary considering the available time series data.

hybrid maize were highest in the landholding category of more than 3.0 ha; also beating the national level yields. However, it was found that yields of local maize were more stable than those of hybrids, which depict fluctuating trends. These results may imply that fear of uncertainties and financial requirements (cash for seed, chemical fertiliser and pesticides) involved in hybrid maize production affect farmers' decision in terms of its allocation on the available land. For local maize, one of the best options for farmers with less than 0.5 ha of farmland is to plant the crop that poses low threats in terms of risks and uncertainties. Besides, potential hybrid yields might have been affected by the use of low rates of inorganic fertiliser. In Malawi, it is generally recommended that 96 kg/ha Nitrogen fertiliser and 40 kg/ha Phosphorus fertiliser should be applied for high production of hybrid maize (Whiteside and Carr, 1997). However this study found that in the 2002 farming calendar, smallholder farmers of Sangadzi area had on average applied between 12.7 kg/ha to 24.9 kg/ha of various types of fertiliser for the land categories of between 0.5 ha–1.0 ha and more than 3.0 ha. Previously, World Bank studies had found that between 1979-81 smallholder farmers in

Malawi used on average, 24.6 kg/ha of chemical fertiliser and 33.3 kg/ha between 1995-97 on arable land (World Bank, 2000). As shown by this study, the situation of fertiliser use by smallholder farmers has not improved in any way.

Comparing between crops, it was observed that only cassava maintained a steady increase in yields with every increase in landholding category, while the trend for other crops shows almost similar patterns. Improvements in cassava yield may be because of the increased attention that farmers with adequate land in Malawi have on this crop after observing its reliability in times of seasonal drought spells. In Sangadzi area and elsewhere in Malawi, cassava has increasingly become one of the most reliable crops competing with maize as a food crop in addition to its role as a cash crop. Although cassava yields at national level were outstandingly higher than those of the Sangadzi area in 2002, time series data (between 1987 and 2002) at national and district levels show similar patterns with those of this study area. For the period 1987-2002 average yield for cassava was 3,667 kg/ha for Mangochi district and 3,405 kg/ha at National level (Malawi Government, 1998a; Malawi Government, 2002).

4.2 Food Sufficiency in Sangadzi Area, 2002

Annual food sufficiency for Sangadzi area was calculated by multiplying the sample population by annual per capita food requirements. Same results can be obtained by multiplying mean household size (persons per household) by annual per capita food requirements at household level. Considering the average annual per capita basic food requirements of 223 kg (Malawi Government, 1998b) and the sample population of 715 people, Sangadzi area needed to produce 159,445 kg ME of basic foodstuffs (715 people $\times$ 223 kg) in 2002. Assuming all the production from these four main basic food crops were meant for household consumption, Sangadzi area had food deficit of 26,106 kg ME (159,445–133,339) kg ME and managed to produce 84% of the people's annual food requirements. Although food management may differ from one household to the other, the general outlook of the study area is that of a food deficit community. Some of the reasons for low food production in Sangadzi area are land shortage and the use of low yielding crop varieties.

Analysing the food situation according to landholding categories, the study found that under the current cropping systems and the prevailing land situation in Sangadzi area, smallholders with less than 2 ha of farmland, could not manage to produce enough food to meet their annual basic food needs. The food situation was unbearably worse for smallholder households with less than 0.5 ha of farmland, producing only 0.24 or 24% of their annual basic food needs (Table 2). These

are the chronic food deficit households (Mkandawire, 1997). Correspondingly, smallholders with landholding between 0.5–1.0 ha are the next group with critical food shortages (with household food sufficiency of only 0.59). Smallholder farmers in the landholding category of 1.1–2.0 ha, while currently unable to produce enough to meet their annual food requirements (food sufficiency at 0.82) could potentially become surplus producers with improved farm management.

5. The Need to Modify Cropping Systems

Considering that almost 86% of the households are food deficit in Sangadzi area, something must be done in order to improve the situation. It is necessary to improve smallholder food production by using holistic approaches in order to improve rural people's socio-economic status while at the same time ensuring sustainable use of the remaining land resources. Increasing the use of hybrid seed and chemical fertiliser could have been the best strategy with which to improve food production and household food sufficiency in Sangadzi area. However, the financial limitations associated with these two high technology inputs and their unavailability in the area leaves farmers with one option, that of modifying or adapting cropping systems to reflect on the current changes of the land situation and their socio-economic status.

In order to facilitate an effective and targeted strategy for improving cropping systems, smallholder farmers should be mapped out according to their different socio-economic conditions. Malawi Govern-

Table 2. Food sufficiency according to landholding in Sangadzi area, 2002

Landholding category	Number of households	Population	Mean household size*	Total annual food requirements (kg, ME)**	Food production (kg, ME)	Annual food sufficiency*** ratio
< 0.5 ha	4	19	4.8	4,638	1,100	0.24
0.5–1.0 ha	53	252	4.8	61,459	36,123	0.59
1.1–2.0 ha	61	308	5.0	70,736	58,169	0.82
2.1–3.0 ha	13	78	6.0	15,075	17,305	1.15
More than 3.0 ha	7	58	8.3	8,117	20,642	2.54
Totals	138	715	5.2	159,445	133,339	0.84

Source: Field survey (2002).

Notes: *Unit for mean household size is number of persons per household. **Total annual food requirements=population $\times$ 223 kg, ME. ***Food sufficiency ratio=Total food production (kg, ME) $\div$ Total annual food requirements (kg, ME).

ment (1995) states that resource-poor farmers with virtually no access to finances should be encouraged to intercrop local maize with pulses such as beans and pigeon peas. However, the old age intercropping practiced in Sangadzi area and all over Malawi has not helped to solve household food problems. Unless a complementary cropping system is introduced to work within the agro-ecological and economic capabilities of smallholders, the situation is likely to worsen considering the decline in landholdings. It is more advisable and practical to encourage land deficit smallholders to adopt double-season cropping systems according to their suitability to respective agro-ecological conditions. Hence, this study proposes the introduction of a modified form of sequential cropping as the alternative strategy to help land deficit smallholder farmers improve production and close the food security gap by maximizing the use of their land as well as labour. With the new modifications, smallholders can choose a farm technology that is readily available and cropping pattern that is most appropriate to them.

5.1 Maize-Cassava Sequential Cropping

Sequential cropping is a system of cropping in which farmers sow two or three short duration crops in succession, especially legumes or oilseeds in lines between agro-forestry trees (Rajasekaran, 1993) and any other major crops. Sequential cropping is adopted in marginal lands, and it contributes significantly to protein production for marginal and small-scale (smallholder) farmers. In Sangadzi area many places maintain adequate moisture for considerable period of the year after harvesting the rainy season crops. As already discussed in section 3.2, sequential cropping involving minor crops such as cowpeas and other fast maturing local peas and beans, has been in practice in Sangadzi area for a long time by few farmers using the available moisture after harvesting major crops. However, no farmer has ever tried the strategy with major crops like cassava. This may be because large scale off-season sequential cropping has not been given recognition in Malawi both in the research and policy framework. Nevertheless, the available moisture could potentially support a significant production of

major food crops like cassava and sweet potatoes. As pointed out by Troeh et. al (1999), most tropical areas have enough moisture and the potential to practice double-harvesting multiple cropping strategies through sequential cropping.

This section presents the modified current small-scale sequential cropping, its envisaged benefits to the farmers in terms of food security and potential improvement in socio-economic status and the agricultural environment. Its continuity with present cropping systems and food habits, maximization of use of local resources and their sustainable management is given due consideration. Hence, cassava the drought tolerant crop that is commonly consumed and grows well in Sangadzi area and all over Malawi is considered as the second major crop, to be planted sequentially with maize. Local maize has been chosen in this proposal because it suits the local financial situation of the majority of smallholder farmers who cannot afford the costly hybrid maize varieties. Thus, this case would give a closer outlook of the actual smallholder situation. The proposed sequential cropping schedule is meant for a year round farming, taking advantage of the moisture available from the cool season showers of May, June and July after the main rains stop falling (Figure 2). In some cases, surface water irrigation using rivers and the lake may appropriately complement the natural moisture.

This cropping schedule will combine basic concepts of intercropping and undersowing. Undersowing generally involves the sowing of grass or clover under a cereal crop so that it is already established when the cereals are harvested. This concept can be applied to sequential cropping of maize and other crops. For instance, cassava can be undersown on maize plot after plucking off some of the leaves of the already matured maize crop to avoid shading the newly sown cassava crop. Fast maturing crops like beans; soybeans, cowpeas and vegetables are to be grown as intercrops as a continuation of the existing process.

Similarly, where sweet potatoes do better than cassava, farmers can plant sweet potatoes instead of cassava as a sequential crop with maize. Practically,

Time Period	Almost dry period			Rainy Season (Rainfall: 750 - 1043 mm per annum)					Spring Moisture (Amount not recorded)				
	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	
Activity 1 (Maize)	Land preparation, ploughing and ridging.			Planting, Weeding and Fertiliser application, Banking, Tethering goats and sheep.					Harvesting maize	Controlled livestock grazing.			
Activity 2 (Sequential cropping)	Harvesting cassava (while at the same time preparing the land for maize planting). Activity crosses over to next farming calendar					Undersowing cassava (after plucking off maize leaves)		Clearing crop residues from harvested crops (to create more space for cassava growth)					

Figure 2. Proposed sequential cropping schedule of maize and cassava
Source: Field survey (1999 and 2002); Rainfall data by Malawi Government (1998a).

cassava and potatoes cannot be inter-planted with each other and therefore should be treated as separate major crops to be intercropped with other crops of farmer's choice. In Sangadzi and other parts of Malawi, most sweet potatoes are harvested within 3-6 months while harvesting of cassava normally starts within 6-9 months of planting depending on variety. Cassava as a drought tolerant crop can also remain in the soil for a considerable period of time after maturity without serious deterioration of the tubers (Malawi Government, 1995). This feature makes it possible for cassava to cross over a number of seasons. Cassava can also be harvested in January or February of the next year after planting and thereby can serve as an insurance against annual episodes of food crisis prevalent in Malawi when the stock of maize almost runs dry throughout the country and when the new maize plant is not yet ready for consumption. Another advantage of cassava is that it is capable of producing reasonable yields on very marginal soils where other crops would fail (Malawi Government, 1995). With this feature, cassava can be adapted to various agro-ecological conditions in Malawi. The proposed sequential cropping schedule considers cassava farming for one season to be managed within 6-9 months using the readily available local varieties of *Manyokola*, *Gomani* and *Mbundumali*. However, depending on availability of planting materials, such varieties as TMS30572, TMS 4(2) 1425 and TMS50395, bred under the support of the International Institute of Tropical Agriculture (IITA),

and with yield potential of 6-40 tons/ha (Babaleye, 1996), could also be planted to boost production.

5.2 Benefits of Maize-Cassava Sequential Cropping

Under proper land use planning and good crop husbandry practices such as early land preparation, timely weeding, use of manure and proper control of pests and diseases, the proposed two-season cropping schedule would increase the cropping intensity and offer the potential benefits of raising food production and improving household food security and sufficiency. It can also improve household nutrition through direct consumption of a variety of minor crops (intercrops) over a longer period in a year. This system can as well help to raise farm cash income through sale of the surpluses. The proposed cropping system also has the potential to enhance land resources conservation and improve soil fertility. For instance, with legumes and cover crop combinations, the system offers the advantage of soil fertility improvement, maintenance of soil structure and control of soil erosion.

Table 3 presents a summary of potential food production and the extent of household food sufficiency under Maize-Cassava sequential cropping strategies. The study found that with one season cropping strategies, all smallholder farmers with less than 0.5 ha of farmland would not manage to produce enough of their annual basic food requirements by growing local maize, or hybrid maize or cassava under the prevailing household sizes, and yield levels. Smallholders growing one-season local maize would

Table 3. Potential household food production and sufficiency under maize-cassava sequential cropping in Sangadzi

Landholding category	Household		One season cropping strategy				Sequential cropping	
			Local maize		Cassava		Local maize + Cassava	
	Mean size	Annual food requirements (kg, ME)*	Food production (kg, ME)	Food sufficiency ratio**	Food production (kg, ME)	Food sufficiency ratio	Food production (kg, ME)	Food sufficiency ratio**
< 0.5 ha	4.8	1,070	275	0.26	961	0.90	1,236	1.15
0.5–1.0 ha	4.8	1,070	471	0.44	1,589	1.48	2,061	1.93
1.1–2.0 ha	5.0	1,115	728	0.65	3,240	2.91	3,968	3.56
2.1–3.0 ha	6.0	1,338	1,424	1.06	6,232	4.66	7,657	5.72
> 3 ha	8.3	1,851	2,184	1.18	14,551	7.86	16,735	9.04

Source: Calculated using survey data (2002); Malawi Government (1998b and 2002).

Notes: *Total annual food requirements per household = Mean household size $\times$ 223 kg, ME. **Food sufficiency ratio = Total food production (kg, ME) $\div$ Annual food requirements (kg, ME)

manage to produce enough food for the annual basic food requirements only if their farmland was more than 1.5 ha. However, with sequential cropping strategies, smallholders with less than 0.5 ha of farmland would be able to produce enough food to meet their annual basic food needs plus a little surplus by sequential cropping of local maize and cassava (1.15 food sufficiency ratio). Farmers with bigger landholdings would have potential to raise their household cash income from the sales of cassava in addition to improved food sufficiency. Similarly, those growing hybrid maize would have food deficits if their farmland were less than 0.74 ha, however, sequential cropping of hybrid maize with cassava could theoretically increase much more food production and enable farmers to fully meet their annual basic food requirements.

This paper has examined the situation assuming 100% of the land would be put to sequential cropping. However, depending on the basic objectives of the farmers, the extent of other household workloads, the size of farmland and the effectiveness of extension services, the strategy may be applicable if the farmland is divided into significant workable proportions of farmer's choice. Nevertheless, it would be advisable for smallholders with less than 0.5 ha not to take the risk of dividing their farmland into small portions for this type of sequential cropping considering unpredictable natural changes that affect agricultural production.

6. Discussion

The results of this study have shown that by growing only maize the majority of smallholder farmers with less than 2 ha of farmland cannot produce enough food to meet their households' annual basic food needs under one-season cropping strategies. However, by adopting the proposed modified sequential cropping strategies, most smallholders have the potential to produce enough food and raise household food sufficiency and security through local maize varieties without adopting hybrid maize varieties, which are costly and difficult to manage. Moreover, despite low levels, the yield of local maize is more stable than that of hybrid maize. Local maize is also less risky than hybrid maize in uncertain climatic conditions. Depending on various food habits, cassava can be consumed directly after processing in a similar manner which rural people traditionally do with maize or it can be sold for money to purchase maize wherever possible to ensure continuity of people's food habits. Cassava tubers, which contain about 80% of carbohydrates, produce high-energy food, and the shoots, which grow into leaves, constitute a good vegetable rich in proteins, vitamins and minerals (Babaleye, 1996). The study observed that the people of Sangadzi area consume the whole cassava plant, using tubers as main food or as a snack served with tea for breakfast, while the leaves serve as side dish or *ndiwo* and the stems serve as a useful source of

firewood.

On land resources conservation, cassava produces and sheds a lot of leaves to the ground, which later decompose and improve soil structure and fertility. However, wherever the strategy poses a threat of soil erosion and loss of soil fertility, emphasis should be on ensuring that all forms of sequential cropping must incorporate cover crops and fertility enhancing crops (like legumes) in order to overcome potential soil erosion and loss of fertility. Where feasible, introduction of agro-forestry may also help to overcome soil fertility problems. By strategically planting trees nitrogen lost over the last 20 years can be replenished with nitrogen from agro-forestry innovations such as hedgerow intercropping with leucaena (Sullivan, 2003). However, field experience has shown that in cassava farms, leucaena can be more beneficial in soil fertility improvement when used as biomass transfer and not as an intercrop because it extracts more nutrients from the soil than cassava. Therefore, cassava farmers can use the leucaena leaves as green manure. Although leucaena grows very well and was common in Sangadzi area, the study found that only one farmer had been using it for soil fertility improvement, while the rest of the farmers who planted leucaena use it to provide shade around the homestead. Farmers said that they do not know the agro-forestry benefits of leucaena trees hence, do not use it for soil improvement. Thus, extension can help to make sequential cropping a more feasible strategy by encouraging farmers to make maximum use of the available local resources, which are not being put into productive use.

7. Conclusion

Food crisis will continue to be a problem among smallholder farmers in Malawi unless current cropping systems are modified to accommodate changes in the physical environment and people's socio-economic situation. Under the prevailing rural poverty and the fast declining farmland, farmers should be encouraged and guided to maximize the use of available land resources without causing further environmental

degradation. Sequential cropping strategies offer a huge potential to solve rural hunger and raise rural income, while at the same time, conserving the land resources. This must be encouraged, backed by an efficient and effective extension and a systematic correct land use planning to identify potential crops that can boost production in various specific agro-ecological locations.

This paper has shown the possibility of bringing changes in cropping systems undertaken by smallholder farmers within the context of their current socio-economic and agro-ecological environment without imposing any drastic changes in management and food habits on them beyond what they already practice. In order to improve household food sufficiency, modifications of the current one season cropping systems to a double season sequential cropping strategies within one year are suggested. In doing so, utmost care is given to have continuity with the current cropping systems and food habits by maintaining with familiar crops in the area. This will enable maximum use of local resources especially, land and labour. While this strategy is scale neutral in terms of farm size, its feasibility is restricted to agro-ecological zones that maintain adequate moisture for longer periods in a year. Farmers in other agro-ecological zones may also adopt such cropping systems to raise food security. However, its potential benefits may not be realised with the application of umbrella approaches of one-size fits all and will have to be supported by good extension policies. The issue of extension policy will be discussed in a different paper.

Endnote

- 1) The 1998 official national rural poverty line was MK9.40 or US\$0.37 per day, (April 1998 Official Exchange rate: US\$1.00=MK25.40). The current poverty lines in Malawi were calculated using a basket of goods necessary to meet the daily basic food and non-food needs of an individual in Malawi.

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