AN ANALYSIS OF GENETIC GAIN FOR SWEETPOTATO ROOT YIELD,VARIETIES RELEASED AND ADOPTION IN MALAWI

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Introduction

Sweetpotato is one of the most important food and nutrition security crops in Malawi. It is grown across the country in different agro-ecological zones of the Agricultural Development Divisions (ADDs; Figure 1). In the Shire Valley ADD, the sweetpotato is grown in altitude ranges of 50 to 200 m above sea level in warm to hot conditions where maximum temperatures ranges from 25 to 49^{0}C with an annual mean of 30^{0}C and under residue moisture. In the rest of the country, sweetpotato production is mostly under rain fed conditions in mid (200>700 m) and high (>1300 m) altitude of the ADDS (Figure 1) with mean annual temperatures ranging from low to medium (21 to 25^{0}C).

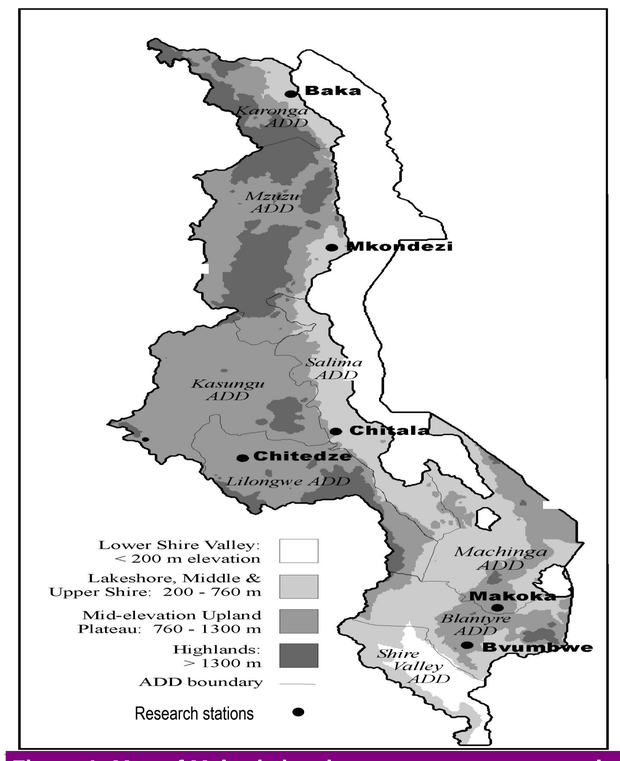

Figure 1: Map of Malawi showing sweetpotato agro-ecological zones in Agricultural Development Divisions (ADD) and research stations

Owing to the rapid population and urbanization increases that have led to high food costs, sweetpotato has become increasingly important in most low income rural and urban homesteads. The production increased from 317,714 in 1995 to 2,695,878 metric tons in 2009, while the production area increased from 60,701 to 164,255 hectares (FAO/FEWS, 1995; FEWSNET, 2009) and a productivity of 17t/ha.

Sweetpotato in Malawi is grown in diverse, small and fragmented plots and mostly in marginal environments by small-scale farmers using different varieties and cultural practices.

Figure 2. Sweetpotato planted towards the end of the rainy season and in sandy soils

Studies by Chipungu (2008) revealed that in most cases, sweetpotato is planted after all other crops, and it is allocated to the poorest portion of land (Figure 2) with the full knowledge that the other crops will not give yield from such a patch.

The ultimate goal of a sweetpotato breeder is therefore the development of varieties which can be adapted to a range of diversified environments including those in Figure 2. In the variety development process, genotypes have to be evaluated in multi-environmental trials (MET) to ensure stable performance (Yan and Rajcan, 2002) before release.

The Department of Agricultural Research Services (DARS) in the Ministry of Agriculture and Food Security (MoAFS) and currently in partnership with Alliance for a Green Revolution (AGRA) is responsible for sweetpotato variety development in the country. One of the major breeding objectives is to develop varieties that are high yielding (>20t/ha) and tolerant to major pests (sweetpotato weevils) and diseases (viruses and alternalia). The breeding program started in 1978 where landraces Kamchiputu and Yoyera (3-7t/ha) were recommended for production in Malawi (Table 1).

Sweetpotato breeding and root yield genetic gain

Screening of introductions, landraces and locally acquired populations over the years have led to the release of improved varieties (Tables 1) that provide high root yields, exhibit tolerance to pests and diseases and have preferred tastes.

Table 1. Improved and released sweetpotato varieties in Malawi

Varieties	Yield (t/ha)	Origin	Remarks
Yoyera	3-7	Landrace	Recommended in 1980s, rarely grown
Kamchiputu	3-7	Landrace	Recommended in 1980s, rarely grown
Kenya (SPN/O)	20-25	Tanzania	Released in 1988, widely grown.
Lunyangwa	20-25	Local bred	Released in 1990, low adoption
Kakoma (TIS 3017)	25-35	IITA	Released in 1993, low adoption
Semusa (Cemsa 74-288)	25-35	CIP	Released in 1999, being adopted
Mugamba (Mogamba)	20-25	CIP	Released in 1999, being adopted
Tainoni (Tainon 57)	18-20	AVRDC	Released in 1999, low adoption
Salera (CIP1941 121)	20-25	CIP	Released in 2002, low adoption
Sakananthaka (LU96/303)	18-20	OP (Malawi)	Released in 2008, Low adoption
Nyamoyo (BV07/008)	8-35	OP LU96/374	Released 2011, new release
Sungani (BV07/016)	30-35	OP Semusa	Released 2011, new release

Key: AVRDC= Asian Vegetable Research and Development Centre; CIP= International Potato Centre; IITA= International Institute of Tropical Agriculture; OP= Open pollinated

The variety Kenya, bred in Tanzania (SPN/O) and introduced into Malawi through Kenya was the first improved variety released in 1988 (Moyo *et al.,* 2001) with a yield range of 20-25t/ha (Table 1).

Figure 3: Sweetpotato on station evaluation trial at Bvumbwe Agricultural Research Station

Further variety development evaluation trials which are done both under research stations and on-farm (Figures 1 and 3) conditions led to the release of more varieties (Tables 1 and 2).

Efforts by breeders have been directed at developing varieties of high root yield for effective contribution to food insecurity reduction. Notably among the highest yielding varieties (30-35t/ha) are two introductions; Kakoma (1994) and Semusa (1999) and most recently varieties developed from locally generated populations; Nyamoyo and Sungani released in 2011 (Table 1).

Recently, in partnership with AGRA, high beta-carotene varieties for a sustainable approach to vitamin A deficiency reduction have been released (Table 2) where Kaphulira and Chipika provide the highest root yield potential of 30-35t/ha. It is important however to note that in the thirty years, no variety has been released that yields beyond 35t/ha despite many potential genotypes encountered in observational and preliminary trials. While performance in terms of yield and resistance to pests and diseases are of prime importance, farmers do also prioritize taste and texture in participatory variety evaluation processes which mostly limits the release of even higher performing varieties and therefore affecting progression in genetic gain for root yield over the years.

Table 2: Recently released orange fleshed sweetpotato varieties of Malawi

Name	Yield t/ha	Origin	Remarks
Zondeni (also noted in Uganda as Ejumula)	8-16	Landrace	Recommended 2008, highly promoted by CIP/Irish Aid
Anaakwanire BV07/028	20-25	Received as OP Ejumula (Uganda)	Released 2011
Mathuthu LU06/146	20-25	OP Mogamba CIP	Released 2011
Kaphulira LU06/428	30-35	OP Mogamba CIP	Released 2011
Chipika LU06/527	30-35	OP Kenya (SPN/O)	Released 2011 under high promotion by CIP/Irish Aid
Kadyaubwelere LU06/252	25-30	OP Mafutha (RSA introduction)	Released 2011 under high promotion by CIP/Irish Aid

Key: OP= open pollinated; CIP= International Potato Centre; RSA= Republic of South Africa

Figure 3: Farmers participating in evaluation for agronomic and taste preference

In Malawi, the process of variety release has been designed to meet the specific requirements of different farmers through multi-location on-farm participatory evaluation (Figure 3). Different varieties have therefore been released that provide choices to farmers in terms of agronomic suitability and taste preference.

Adoption of released varieties

DARS has recommended three landraces and released 15 improved varieties since the start of the sweetpotato improvement program(Tables 1 and 2). In the past two decades, Malawi Government in partnerships with International Potato Centre (CIP) and NGOs disseminated these varieties to farmers. On-farm demonstrations (Figure 4) and vine multiplication (Figure 5) have also been main approaches of variety dissemination.

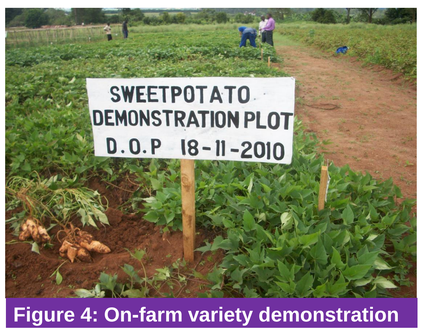

Figure 4: On-farm variety demonstration

Figure 5: On-farm vine multiplication

Of late, efforts have also been directed at disseminating orange fleshed sweetpotato (OFSP) varieties for increased adoption and utilisation and therefore a sustainable contribution to vitamin A deficiency reduction.

Figure 6: Youth in OFSP chips enterprise

Figure 7: Variety Zondeni best for crisp

The promotion of orange fleshed sweetpotato has taken an extra mile as apart from on-farm demonstration and dissemination of vines, farmers are trained on the utilisation modes and value addition of OFSP which include young men who are engaged in chips enterprise (Figure 6). In partnership with Universal Industries, a biscuit and crisp processing company, Zondeni (Figure 7) was one of the best for crisp making.

In general, the high yields that have been recorded in Malawi can be attributed to the adoption of improved varieties. However, a germplasm collection survey in 2003, revealed that Kenya was the most widely grown variety across the country and it was collected under ten different names (Chipungu, 2008). Zondeni, an orange fleshed variety is the second widely grown cultivar which along with the newly released OFSP varieties is under high promotion by International Potato Centre facilitated by Irish Aid. It is also important to note that farmers grow the improved varieties along with their own landraces an indication that apart from involving them in variety selection, there is also a strong need for civic education to increase adoption and utilisation of the released varieties for high yields and improved food and nutrition security.

Conclusion

Through the breeding program, three landraces and 15 improved varieties that yields up to 35t/ha have been released. Potential to identify varieties that yield >35t/ha is high if varieties are released for value addition. The improved varieties have contributed to increased productivity from 3-5t/ha (1995) to 12-17t/ha (current) at farm level.

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