

Review

# Soya bean *glycine max* (L.) Merr. genetic resources in Tanzania, 1905-2013

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Received 28 July, 2015; Accepted 11 September, 2015

Soya beans, first grown in what is now Tanzania early in the twentieth century, have always been a minor crop in area planted and total production. German East Africa introductions before 1918 were from Japan, China and Rhodesia. Introductions by the British Trusteeship of Tanganyika in 1938 and 1939 were from India, South Africa, the USA and the Far East. Hernon 237 was introduced in 1950 to replace the American variety Dixie. Experiments at Nachingwea by the Overseas Food Corporation resulted in development of high-yielding and locally adapted varieties in the 1950s and 1960s. Research at Kilosa in the 1970s, based on Nachingwea varieties, emphasized intercropping, fertilization and promiscuous nodulation. The international agricultural research institutions was assisted with introductions and expertise during the 1980s. Soya research has shifted among research centres several times but in the twenty-first century, only Uyole in the southern highlands, with limited human, financial and material resources, works on soya breeding. Two strains from this centre plus the Bossier variety are the only types registered by the national plant certification authority. Smallholder farmers do their own research and adaptive trials with Zambian material. Some large scale farmers grow soya as an alternative crop and to supply protein to the animal feed industry. In spite of oft-expressed intentions by government to support soya and publication of a national soya development strategy in 2010, there has been little increase in area planted and in output. Producers continue to face problems in seed supply, technical advice and marketing.

**Key words:** Biodiversity, plant breeding, varietal trials, promiscuous varieties, *Rhizobium*, nodulation.

## INTRODUCTION

Much of Tanzania in terms of rainfall, temperature and soil type is suitable for soya bean *Glycine max* (L.) Merr. cultivation. Cultivated area and total production are insignificant, however, compared to the major cereal staples (maize, millet and rice) and grain legumes

(groundnuts, common beans, sesame and pigeon pea), such that soya is, and always has been, a minor crop in Tanzania. Soya bean contributes, nonetheless, to national and household food supply, provides income, adds diversity to arable systems and fixes nitrogen that

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improves soil fertility and condition (MAFC, 2010). Much of Tanzania is suitable for soya cultivation and the bean is indeed grown in most areas. Favoured areas, however, are the Southern Highlands (Iringa, Mbeya, Rukwa and Ruvuma Regions), Morogoro Region, the southern Lindi and Mtwara Regions and the northern Arusha, Kilimanjaro and Manyara Regions (Malema, 2005; 2007).

Production of soya bean is mainly for the domestic market but supply is much less than demand. Formal imports to overcome the deficit are mainly from India and neighbouring countries.

There are also "informal" imports from Tanzania's contiguous states. Most soya is grown by smallholder farmers under rainfed conditions in small plots using traditional husbandry methods and sowing local or "nondescript" varieties that are produced from home saved seed (Chianu et al., 2008). Some larger mechanized farms in the so-called Ilemi Cluster of the Southern Agricultural Growth Corridor of Tanzania (SAGCOT) already produce, or have well advanced plans to produce, soya bean: these are or will be partially vertically integrated operations with some degree of processing and organized marketing (SAGCOT, 2012). Soya bean contributes much less than 1 per cent to Agricultural Gross Domestic Product (GDP) at present but has great potential to bestow much more. In the 50-year period from 1961 to 2011 the area cultivated to soya varied from as much as 16,000 ha to as little as 2000 ha with the greatest area grown in the early 1960s and the smallest in the late 1980s and early 1990s (FAO, 2012). (The larger area planted in the early 1960s is largely due to the 6000 ha grown by the then Tanganyika Agricultural Corporation (TAC) – successor to the notorious Overseas Food Corporation or "Groundnut Scheme" – on its 18 farms around Nachingwea in Mtwara Region (DoA, 1958, 1962; Auckland, 1970): the author of this paper was responsible for the management of two of these farms in this period and grew about 1000 ha of soya). One source quotes annual production of grain soya in the early twenty-first century as being in the range of 3000-5000 tonnes from a cultivated area of 5000-6000 ha (Malema, 2005). Another source, based on Ministry of Agriculture sample surveys, indicates average production over the two years 2003/2004 and 2004/2005 of 1000 tonnes of grain from under 2000 ha equivalent to a yield of 727 kg/ha (ICRISAT, 2011).

This paper reviews the import, export, development and use of soya bean varieties in Tanzania (formerly German East Africa and Tanganyika) over a period in excess of 100 years.

## RESEARCH, DEVELOPMENT AND USE OF SOYA BEAN GENETIC RESOURCES

It is reported anecdotally that soya beans were first

introduced to what is now Tanzania in 1907. This date is given by innumerable secondary sources but there is no firm reference to support the claim nor is there any indication of who imported them, whence they came and by what route. The first reliable and documented source (Greenway, 1945) states that there were introductions from the USA in 1909 and further introductions from Japan, China and South Africa in 1911 (Table 1). These last introductions, seven from Japan, one from China and three from South Africa, are referred to in more detail in a paper - which is the probable source of the information provided by Greenway (1945) - published by the then German Biological Agricultural Research Institute in Amani (Biologisch Landwirtschaftlichen Institut Amani) (Eichenger, 1912). This latter paper details seven varieties from Yokohama in Japan, five – Natsu-Mame, Shiro Daizu, Ao Mame, Gogatsumame and Daizu – being white and two -- Kuro Teppo and Kuro Mame – being black, one from China – Chinese white type – and three unspecified varieties from Rhodesia (Eichenger, 1912). There is no reference in this authoritative paper to any earlier introduction to German East Africa nor is there in two earlier papers from the same institute, the one devoted to soya beans in British South Africa (Anon., 1910) (the paper did, however, suggest that soya might shortly become an export crop as a Lever Brothers soap factory intended to buy soya beans produced locally for making oil and soap.) the other being a more general paper on soya and its uses (Reiter, 1910). Another unsubstantiated statement refers to soya beans being introduced to the Masasi and Nachingwea Districts in Mtwara Region (in southern Tanzania) prior to 1918 (MAFC, 2010), that is, prior to German East Africa becoming the League of Nations Territory of Tanganyika under the administration of the Government of the United Kingdom of Great Britain and Northern Ireland (Greenway was working at Amani when he published his papers). No more introductions appear to have been made until 1938 and 1939 when 64 cultivars were established at Amani via direct imports from India, South Africa and the USA together with a large number of American and Far Eastern cultivars arriving from Rwanda (Auckland, 1970). Soya beans were grown in the Bukoba area during the period of the Second World War and, depending on the source of the information did well (Auckland, 1970) or did badly (Mmbaga, 1975).

The Overseas Food Corporation (OFC, colloquially known as the "Groundnut Scheme") presumably accepting that it would get little oil from its eponymous crop started soya bean cultivation in Nachingwea in 1947 but the cultivars used produced low yields and proved unsuitable to the conditions of southern Tanzania. OFC then employed a breeder to improve the country's gene pool of the time. Hernon 237 was introduced from Rhodesia (Zimbabwe) to replace the Dixie variety (Auckland, 1970), which was possibly from the USA

**Table 1.** Summary of soya bean genetic resources used in Tanzania, 1907-2013.

Time period	Location	Variety
< 1915	Amani	USA – unspecified (1909); China – 1 variety Chinese white type (2); Japan (Yokohama) – Natsu-Mame (white), Shiro Daizu (white), Kuro Teppo (black), Kuro Mame (black), Ao Mame (white), Gogatsumame (white), Daizu (white); South Africa – unspecified
1938-1939	Amani	64 cultivars USA, India and South Africa and via Rwanda from “America” and Far East
1950	Nachingwea	Hernon 237 introduced from Rhodesia [Zimbabwe] to replace Dixie variety (presumably USA variety from 1938-1939 imports)
1957-1963	Nachingwea	New adapted varieties for lowland conditions included IH/192 (“Tanzania’s standard line”), 3H/1, 3H/101, 7H/149/1: Hernon 237 x Light Speckled, Hernon 237 x R184 and Benares x Light Speckled produced highest-yielding and most agronomically desirable strains: over 5-year period HLS [Hernon Light Speckled] 219 out yielded parents Hernon 237 by 40% and Light Speckled by 37%
mid 1970s	Miwaleni (Pemba)	Missay, Belgian Congo
1978	???	Recommended varieties were Bossier (from Bossier City, Louisiana, USA) and 3H/1
1982	Sokoine Agricultural University	F <sub>6</sub> lines (IH/192 x Bossier), Caribe, Orba, TCM249-4-6, 245-4-OTRS, Calland, Tunia, Tracey, Hardeel S, CS90, IH/192, Improved Pelican, CH-3; F <sub>7</sub> and F <sub>8</sub> lines to be tested in future
1981-1982	Ilonga and Kilosa area	79S0047 F4, GPM L-2, SI-4, 59S0057 F4-1, TGM 622, TGM 737 x 80, S3-2, 79S0018 F4, GPM L-4-2 and 3H/I
1992	Selian	Bossier, Bossier IL, Duiker, Sable, EAI 3715, Still, Delma, SAB/7, PERY 41
1997-2000	Various locations	AGS292, AGS329, AGS338 and AGS339 lines from AVRDC Arusha Centre provided to research organizations for testing
2002-20013	Uyole	Uyole Soya 1 (SH1), Uyole Soya 2 (SH2)
2005	Ilonga	TGx 1876-4E, TGx 1895-4F, TGx 1895-33F, TGx 1895-49F (IITA varieties developed under TLII project)
2012	Ihemi Cluster	Songea (long season, nodulates with local bean Rhizobium), Squire (good rust resistance but poor germination), SB8, SB19, Solitaire, Dina, Pan
Continuing	Farmer fields	Soyalishe, TGx 1805-8E, Songea, Safari, Bossier, Kareya, Kaleya, Ndogo, landraces described on morphology (seed size and colour, hymen colour)
Likely future	Station and farmer fields	WF-L19, Maksoy 2N, Namsoy 4N x Uganda (for release by Uyole); Namsoy, TGx 1740-2F, TGx 1987-64F (from N2Africa/Kenya); Squire, Safari, Spike, Semeki (from SeedCo, Arusha)

Source: Compiled by the author from citations and references in the text.

import in 1938. Breeding new varieties adapted to the lowland conditions of southern Tanzania continued from

1956 to 1963 and several cultivars were released during this period. This included IH/192 (described as



**Figure 1.** A strong crop of Hennon 237 x Light Speckled soya bean on Farm 4 Nachingwea in March 1965 (Photo: R Trevor Wilson).

“Tanganyika’s standard line”), 3H/1, 3H/101, 7H/149/1. Hybrids such as Hennon 237 x light speckled (Figure 1), Hennon 237 x R184 and Benares x Light Speckled produced the highest-yielding and most agronomically desirable strains: over a 5-year period Hennon Light Speckled (HLS) 219 out-yielded its parent Hennon 237 by 40% and its Light Speckled parent by 37% (Auckland, 1966; 1967). The Tanganyika Agricultural Corporation successor to the OFC also grew soya beans at its Urambo site in western Tanzania and at its Rufiji Basin site where it mainly tested the effects of rotations and fertilizer application on a range of oil seed and cereal crops (TAC, 1958; 1960).

Agronomic and health studies continued throughout the 1960s and 1970s and into the early 1980s. At Ilonga to the west of Morogoro attention was given to the use of insecticides for the control of soya bean pests using varieties that had been developed at Nachingwea (Robertson, 1969). Trials to find soya bean varieties adapted to the middle altitudes (as opposed to the lowland coastal and highland southern and northern areas) were carried out in the Morogoro area in the early 1970s (Uriyo, 1974) but no practical outcome appears to have been achieved. A programme was initiated at Sokoine University of Agriculture also in the Morogoro area in the late 1970s and early 1980s in attempts to breed varieties with enhanced nitrogen fixation capability: no such varieties were bred but strong responses to inoculation by extant varieties were observed (Chowdhury, 1977; Chowdhury and Dottu, 1982; Chowdhury et al., 1983). Additional experiments at Sokoine included the varieties Caribe, Orba, TCM249-4-6, 245-4-OTRS, Calland, Tunia, Tracey, Hardeel S,

CS90, IH/192, Improved Pelican, CH-3 and of  $F_6$  lines of IH/192 x Bossier with  $F_7$  and  $F_8$  lines to be tested in future (Doto, 1986).

Studies at Lyamungu on the lower slopes of Kilimanjaro in northern Tanzania also showed the benefits of inoculation but best yields were obtained when inoculation was combined with a dressing of 40 kg/ha of phosphorus and without nitrogen (Sachansky, 1977; Ndakidemi et al., 2006). In further experiments it was demonstrated that cultivars bred and selected in Tanzania were compatible with native *Rhizobium* spp. whereas the USA variety Bossier did not nodulate unless it was inoculated. The local cultivars were promiscuous and recognized *Rhizobium* species that were ineffective on USA material but they had low yield potential in contrast to the USA cultivars. The latter were agronomically superior but required inoculation with *R. japonicum* to realize their yield potential and it was suggested that a breeding programme based on transferring the promiscuous character of local cultivars to improved USA material could produce varieties that did not require inoculation and still produce high yield (Pulver et al., 1982; 1985).

Further attempts to improve yields as well as the acceptability of soya beans by local peasant farmers involved intercropping, already a traditional practice using other combinations of cereals and legumes (Finlay, 1975; Jana, 1980; Nyambo et al., 1982; Kang, 1983). One report indicated some 1800 hectares had been sown as trials in intercropping and that 2000 hectares had been sown in a “peanut” area (Freckman, 1975) (Freckman was reporting on a conference held in Ethiopia in 1974 and is thus not a primary source: if the peanut area refers

to the Nachingwea groundnut scheme then the information was clearly very much out of date. He also stated that Japan had been seeking rights to grow soya in Tanzania for export to Japan). Trials were not confined to the mainland, however, as in the mid-1970s at Miwaleni on the island of Pemba experiments involving production of two crops per year under irrigated conditions indicated that an annual yield of more than 3000 kg/ha could be achieved: the best yielding varieties in these circumstances were Missay (3100 kg/ha) and Belgian Congo (2666 kg/ha) (Sachansky, 1976).

By 1967 the research arm in Senegal was testing 23 Tanzania soya varieties for its own conditions and later released some to other West African countries (Larcher, 1980; Larcher et al., 1988). Tanzanian seeds were tested in a trial of 24 collections to examine the effects of fungal infection on subsequent germination characteristics (Paschal and Ellis, 1978). Several Tanzania lines were also tested in the Solomon Islands in the South Pacific Ocean (Holsheimer, 1960) as, probably, was the Nachingwea-bred HLS in Tonga (Anders, 1976). Conversely, 10 years later, Tanzania participated in adaptive trials undertaken in many countries which showed that the Tanzania variety Hernon 237 was one of only ten out of 400 worldwide varieties that were promiscuous in their nodulation (Pulver et al., 1985). In the mid-to late-1970s soya was tested in Tanzania as part of a wide scale international variety testing programme (Judy and Whigham, 1978; Whigham and Judy, 1978; Judy and Hill, 1979).

In an attempt "to increase Tanzanian food production" the United States Agency for International Development and the Tanzania Government allocated US \$14.9 million to a seed multiplication project to be managed by a private American company in 1971. One objective was to increase Tanzania's production of soya beans from the then annual 500 bushels (13.6 tonnes) to 3 million bushels (81 thousand tonnes) as a contribution to the 21 million bushels (567 thousand tonnes) needed to supply oil and protein needs (Soybean Digest, 1971). During this period, with continued financing from the USA, more than 600 soya bean accessions were assembled at Ilonga for studies on yield, disease and insect resistance (IITA, 1982). In 1981-1982 some ten new breeding lines, 79S0047 F4, GPM L-2, SI-4, 59S0057 F4-1, TGM 622, TGM 737 x 80, S3-2, 79S0018 F4, GPM L-4-2 and 3H/I with yields varying from 1962 to 2945 kg/ha considerably outperformed Bossier with a yield of only 1241 kg/ha.

Another source indicates that Tanzanian soya production was 4000 tonnes in 1970, an increase of one third over the 3000 tonnes of 1960-1964 (IRAT, 1972). The National Grain Legume Research Programme became operational in 1974/1975. As part of this programme soya beans returned to Nachingwea when 750 ha were planted on a parastatal and a prison farm with plans to expand large scale mechanized production to 8000 ha

over 5 years coupled to the construction of an oil mill to process soya beans, sesame and groundnuts. It was also considered that soya beans were a promising cash crop for 'ujamaa' (Tanzania version of social collective) villages (Brockman, 1977). Public research on and government support for soya beans since the 1970s has, however, been spasmodic and inconsistent in spite of oft-repeated official statements of their importance and the need to increase output.

The Agricultural Research Institute (ARI) at Naliendele in Mtwara Region was designated and acted as the coordinating centre for the Oilseeds Research Programme (ORP) in 1978 but its main emphasis in the twenty-first century is sesame and groundnuts. Varietal research has also been undertaken at Ilonga (on at least two discrete occasions, 1960 to 1969 and from 1973 onwards) in Morogoro Region, at the Kilombero Agricultural Research and Training Institute (1968 to 1976) in Morogoro Region, at Lyamungu ARI (from 1978) in Kilimanjaro Region and at Selian ARI in Arusha Region (from 1986) and at the nearby Lambo Estate (Mwandemele and Nchimbi, 1990; Malema, 2005).

A continuation of the breeding programme in the later 1970s comprising a second phase at Ilonga and new work at Lyamungu aimed to obtain new varieties with: high yield; high protein and oil content; resistance to lodging and shattering; resistance to major diseases; good branching habit; medium plant height of 60-90 cm (traditional Tanzania varieties were 130-150 cm tall and took 210-240 days to mature); ability to set pods at 10-15 cm above the ground; and good adaptation to the local environment (Chianu et al., 2008; Malema, 2005).

A programme to find alternatives to the traditional crops was initiated at Selian in Kilimanjaro Region in 1986. Soya beans were included in the mix with variety trials using Bossier, Bossier IL, Duicker, Sable, EAI 3715, Still, Delma, and SAB/7 being carried out at Selian and also at Lambo Estate (Kilimanjaro) where PERY 41 was added to the varieties (Mwandemele and Nchimbi, 1990). Yields were generally low, ranging from 270 kg/ha for Bossier IL to 1430 kg/ha for Duicker.

At the turn of the twenty-first century the International Vegetable Research Centre (AVRDC) provided seeds of four soya lines (AGS292, AGS329, AGS338 and AGS339) to National Research Institutes from its centre in Arusha for further evaluation and future release (Chadha and Oluoch, 2001). Since the beginning of the new millennium except for a short-lived trial at Kilosa in 2005, Uyole ARI is the only public sector institution working on soya bean breeding. Uyole has released two new varieties (which have not proved successful in the real life situation of either small or large farms), these being Uyole 1 in 2004 and Uyole 2 in 2011 and continues to test new lines (Figure 2) although the human (one researcher), material and financial resources allocated to the programme are meagre. The two Uyole varieties and





**Figure 2.** Soya bean genetic resources in Tanzania: Line 19 under test in 2013 (left) and Uyole 1 released in 2004 (right) (Photo :R Trevor Wilson).

Bossier are the only varieties approved by the Tanzania Official Seed Certification Authority (Catherine Madata, personal communication).

Objective 7 of the Tropical Legumes II Project is “Enhancing promiscuous, multipurpose soybean productivity and production in drought-prone areas of sub-Saharan



**Figure 3.** Variety Dina showing (left) good nodulation and (right) strong growth at Makota Farm, Southern Highlands (Photo: R Trevor Wilson).

Africa” [Tropical Legumes-II, a project funded by the Bill and Melinda Gates Foundation, is a joint initiative of three international agricultural research centres -- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT, working on chickpea, groundnut and pigeonpea), the International Institute for Tropical Agriculture (IITA, cowpea and soybean) and CIAT (common bean)]. As part of this project several IITA varieties (TGx 1876-4E, TGx 1895-4F, TGx 1895-33F, TGx 1895-49F) along with Bossier were screened for their nodulation and seed production properties at Kilosa during 2005. Experimental plots were very small, averaging 0.28 ha for a total of 1.4 ha and yields were very low in the range of 436 to 861 kg/ha (Malema, 2007).

Some semiformal and frankly informal research and observation trials are undertaken by smallholder farmers. In this case it is clear that the country's most widely grown variety, Safari, which is not licensed in Tanzania, was first introduced in unofficial cross border transactions from Zambia by smallholders acting on their own initiative. Safari, developed by Seed Company Limited in Zimbabwe, is an indeterminate variety with high seed yield potential and is well adapted to altitudes in excess of 900 m, is resistant to lodging, has a long period during which it does not shatter and can thus be harvested with little loss of yield and has good ground clearance of the bottom pods. Seeds are of medium size with a yellow hilum and are of good quality. Other varieties grown by small farmers include Soyalishe, TGx 1805-8E, Songea, Bossier, Karea, Kaleya and Ndogo. In addition many local landraces that are referred to or described by morphology (seed size and colour, hymen colour) are grown in various areas (several smallholder farmers, personal communications). Some varieties, and notably the long-season Songea variety is well known for being promiscuous and is favoured by small farmers for this

reason as most attempts to breed such varieties have had little field success and the constant search for variety-specific rhizobia has ended with similar results (Malema, 2005).

Some (“informal”) observational trials are undertaken by large farmers in the Ihemi Cluster using both local varieties in addition to others developed in western Kenya and provided by the Centro Internacional de Agricultura Tropical (CIAT) through the N2Africa Programme (N2Africa is also funded by The Bill & Melinda Gates Foundation through a grant to Plant Production Systems, Wageningen University who lead the project together with CIAT-TSBF, IITA and many partners in the Democratic Republic of Congo, Ghana, Nigeria, Kenya, Malawi, Mozambique, Rwanda, Tanzania and Zimbabwe). As with smallholder farmers Songea has been shown to do well in large part because of its ability to nodulate with local bean *Rhizobium*. Excellent nodulation and strong growth are exhibited by the Dina variety (Figure 3). On the other hand Squire is a poor germinator (Figure 4) and does not grow well probably because it does not have good nodulation traits but does appear to have good resistance to rust. Other varieties being tested on large and emerging farmer scales include SB8, SB19, Solitaire and Pan (Rick Ghai, personal communication).

The soya bean is reputedly resistant to many common legume pests and diseases and especially those of the common beans *Phaseolus vulgaris* grown in Tanzania. This does not mean, however, that it is disease free. A report of 1962 discusses soybean mosaic virus disease on soya in Tanzania (DoA, 1962). Peanut mottle virus was isolated from naturally infected soya beans in the early 1970s with *Aphis craccivora* being the vector (Bock, 1973). Soybean bacterial blight (*Pseudomonas savastoni* pv. *glycinea*) was first noted in Tanzania in 2003 (Catherine Madata, personal communication).





**Figure 4.** Variety Squire with poor germination and weak growth (foreground) compared to variety SB19 (background) at Kisolanza Farm, Southern Highlands (Photo: R Trevor Wilson).

Soya Bean Rust caused by the fungus *Phakopsora pachyrhizi* was first noted on soya beans in 2008 (Catherine Madata, personal communication) and has since been the subject of some studies in 2012 to 2014 (Murithi et al., 2014) although the pathogen had been recorded in Tanzania as early as 1979 (Ebbels and Allen, 1979; Terri and Keswani, 1981). Soya Bean Rust can reduce yields by up to 90%. Safari is generally resistant to or tolerant of most soya bean pathogens but its high susceptibility to Soya Bean Rust means it may require spraying against the fungus two or even three times during the growing period. Soya Bean Rust is now the subject of a special programme being implemented by IITA in Tanzania and its neighbouring countries but its main rust-resistant variety TGx 1835-10E has yet to be made available. Other potential soya diseases that may need research in the future include Frogeye Leaf Spot, Wildfire, Downy Mildew and Red Leaf Blotch (Catherine Madata, personal communication).

## DISCUSSION

In 2015, the soya bean had been cultivated in Tanzania for more than 100 years. Research on genetics and

agronomy and transfer of the benefits of such activities to producers has been spasmodic. Varietal research have been carried out in widely differing areas, has usually been of short duration and has mainly depended on special or external funding. Soya bean has always been a minor crop and its contribution to individual and national income and to human food and animal feed is minimal and is still negligible compared to many countries. In the early 1980s it was said that the crop's potential had yet to be realized (Ayiseni, 1982), a premise which still holds in 2015. Research and extension services have been weak in supporting soya production, as a result of which farmers have limited knowledge of the crop's cultivation and its potential as a food crop for human consumption and as a high quality protein feed for livestock. Marketing, processing and use of the crop remain problematical (Chianu et al., 2008) in large part because the soya bean value chain is weakly developed (SAGCOT, 2012; Wilson, 2015).

The matrix "promiscuity-*Rhizobium*-inoculation" has long been a research subject. Early identification of native promiscuous varieties (Pulver et al., 1982), useful *Rhizobium* species (Chowdhury, 1972; Chowdhury and Doto, 1982; Chowdhury et al., 1983) and of the benefits of inoculation with *Rhizobium* to increase nitrogen fixation



and grain yield (Sachansky, 1977; Pulver et al, 1982) have not been pursued nor have the benefits been transferred to farmers fields. Inoculants were produced at the University of Dar es Salaam as part of an FAO project to select better strains of rhizobia (Mugabe, 1994) and Sokoine University of Agriculture developed commercial inoculants (“Nitrosua”) for both soya and common bean and also undertook extension work to disseminate inoculants. As all these activities were dependent on external funding they came to a halt when the projects reached their termination date (Bala et al., 2011).

Direct Government interest in soya bean since Independence in 1961 has been limited and intermittent (URT, 2006). Some new varieties have been released and others are being developed and tested. In common with the whole research community, attempts to improve soya production and processing have endured limited funding and outmoded equipment for many years and research and development (R&D) have suffered as a result. Extension services for soya are particularly weak and devolution of these from the central Ministry and its branches to local authorities (who are even more constrained for funds than the ministry and its specialized institutions) has been a brake on expanded production. Some seeds and fertilizer and crop health inputs are available at small private outlets throughout the highlands and indeed over most of the country but these are not specific to the soya bean. The official availability of certified seed is low. The fact that only three varieties are on the approved list further reduces interest by farmers in growing the crop. Problems in expanding the approved list arise from the bureaucracy and inadequacy of the official seed certification authority and the reluctance of the international seed breeding companies to supply the country because of problems with intellectual property rights.

Actual or potential soya outlets in Tanzania include household consumption, small and medium scale food processors, small and medium-to-large scale animal feed processors and exports. Local production is dominated by small farmers who cannot benefit from economies of scale and often make “emergency” sales for immediate needs. Low or sporadic demand for soya and its products and tenuous market linkages do not encourage farmers to invest in soya production. Small traders buy at the production point and move the product to processors and consumers in a generally ill-defined chain. Small traders dealing in small amounts that are subject to physical and biological degradation do little to improve the end product. Some beans are sold in local markets to a few small scale processors for incorporation in “fortified” local foods (Laswai et al., 2006; Laswai and Mutayoba, 2007) but demand for home consumption is extremely limited.

Animal feed processors continue to use local low cost fishmeal (‘dagaa’) as the main protein ingredient. The

associated human health risks (due to *Salmonella* contamination) and the taint (“fishy taste”) imparted to poultry meat are widely accepted. ‘Dagaa’ is a lower quality protein than soya bean meal, a fact that is encouraging some feed manufacturers to turn to international soya markets where standardized quality beans and meal are available. Import substitution should be a further driver to increased domestic soya bean production.

Broad opportunities exist for enhancing the soya bean value chain from the research arm to the consumer. Continuing interest in the crop is not only from the Government but also from international development agencies and Non-Governmental Organizations [especially the ‘Soya ni Pesa’ (Soya is money) project of the Catholic Relief Services] (CRS, 2012) as well as the private sector. The bulk of the literature on soya bean produced in Tanzania in recent years has been philosophical rather than practical (Malema, 2005; 2007; Malema et al., 2007). The publication of the Tanzania Soybean Development Strategy (TADS) 2010 to 2020 (MAFC, 2010) was hailed as a milestone in public support for soya production but sets totally unrealistic physical targets rising from its baseline 5000 tonnes of soya grain from 5000 hectares in 2010 to 2.0 million tonnes from 1.4 million ha with 40% being used for processing and 35% for export by 2020. The potential for greatly increased production and for export is, nonetheless, enormous. Tanzania has natural resources suitable for soya bean production and the country is well placed geographically to supply external demand. It has so far failed to capitalize on its natural comparative advantage and there have been virtually no exports of beans or meal.

Some 40 years ago it was written that the “Future prospects for the soybean in Tanzania are absolutely bright” (Mmbaga, 1975). That statement could be true today. For it to become true, however, much more work needs to be done on breeding soya bean genetic resources adapted to local conditions, able to nodulate profusely (either promiscuously or with the assistance of inoculation), resistant to local pests and diseases and perhaps above all acceptable to farmers. Such research will need to be only the first link in a chain that extends through pertinent advice, transparent marketing, appropriate processing and purchasing by consumers.

### Conflict of interest

The author declares that there are no conflicting interests.

### ACKNOWLEDGEMENTS

Thanks are due to the Catherine S. Madata (Research

Officer (legumes), Southern Highlands Zone Agricultural Research Institute, Uyole) for invaluable information on breeding and on actual and emerging diseases of soya beans in Tanzania. Rick Ghau (Partner, Jilanjo Ltd, Kisolanza, Southern Highlands) spent a great deal of his valuable time in talking about his soya trials and conducting me around large farms in the highlands south of Iringa. Many smallholder farmers were very patient with me in discussing their successes (few) and problems (many) with soya beans. Father Nestor Mtevwwe (NDO/CARITAS Director, Roman Catholic Diocese of Njombe) also gave of his time and knowledge of soya bean cultivation in the Njombe and Mbeya areas. Joan Kimirei and Peter Jimbuku were good companions during parts of the field work which itself was facilitated by Michael Winklmaier. I am grateful to three anonymous referees who made comments on the draft paper.

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