Tanzania

Groundnut

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Importance of the crop to Tanzania's economy

Relevance to the economy

Tanzania has adopted "*Kilimo Kwanza*" (Agriculture first) as a strategy and approach for agricultural development because 80% of Tanzanians live in rural areas and 70% are employed in agriculture, which contributes 95% of national food requirements (Asfaw and Shiferaw 2009, COSTECH 2009). The strategy is based on ten actionable pillars with clear focus on poverty-reduction. The agricultural sector not only employs the majority of Tanzanians but also contributes 27% to the GDP (ASDP 2005, URT 2010). Groundnut is among the crops that have been identified as strategic crops in order for Tanzania to realize the "Green Revolution". Emphasis should be in the following areas of interventions:

1. The development and/or adoption of cost-effective technologies that would strengthen seed production and delivery systems
2. Development of high-yielding and adapted (drought tolerant, improved nutrition value, pest and disease resistant) varieties
3. Development and dissemination of knowledge and skills for small, medium and large-scale farmers to adopt intensive agricultural technologies
4. Development and/or adoption of value addition technologies to increase value and marketability of groundnut

Production

In Tanzania groundnut is grown by smallholder farmers and is one of the major raw materials for edible vegetable oils in the country. It is one of several oilseeds produced in the country. Groundnut is mainly used as food crop and consumed directly. Because groundnut is both a food and cash crop, large quantities are sold in informal markets. The most important growing regions are Mtwara, Tabora, Shinyanga, Kigoma, Dodoma and Mwanza, where annual rainfall varies between 500 and 1200 mm. The main groundnut growing zones have different rainfall amounts and distribution during the growing season with unimodal distribution in the south and central and bimodal in the northeastern and lake zone covering Morogoro, Mwanza, Arusha and Kilimanjaro. The zones with bimodal rainfall distribution have short rains in November/December and long rains from March to May/June. Groundnut is grown entirely under rainfed condition. The area under groundnut in Tanzania is estimated to be 542,000 ha with a rate of growth of 4.63% per annum. The national average yield is 721 kg ha^{-1} (MAFSC 2011).

Groundnut seeds contain 40–50% oil, 20–50% protein and 10–20% carbohydrates. They are a nutritional source of vitamin E, and of some other minerals for human health. The latter include niacin, falacin, calcium, phosphorus, magnesium, zinc, iron, riboflavin, thiamine and potassium (USDA 2011). Groundnut is useful in the treatment of hemophilia, and can cure stomatitis and prevent diarrhea. It is beneficial for growing children, and for both pregnant and nursing mothers. Kernels are consumed directly as raw, or as roasted or boiled nuts. Some of the extracted oil from the kernel is used as culinary oil. However, some of the crop-extracts are used as animal feed. In other words, almost every

part of the groundnut plant is used in some way. While kernels are used for human consumption, vines are used as fodder for cattle. Sometimes raw items of the crop are used as industrial materials for producing oil-cakes and fertilizer. Literally speaking, all these multiple uses of groundnut plant make it important for both food and cash crop for the available domestic, or worldwide external markets in several developing and developed countries.

Research and development

Historical perspectives

The Research Program for groundnut improvement in Tanzania was started in early 1950s, at Nachingwea and Kongwa to support the then British Overseas Food Corporation (OFC) groundnut scheme. This led to recommendation of groundnut varieties Natal Common and Red Mwitunde, plus a package of agronomic practices. Following the collapse of the OFC in late 1950, an oilseed breeding program that also included sesame and soybean was initiated at Nachingwea. Groundnut research conducted after independence was inconsistent and lacked cohesion. However, activities conducted and recommendations (eg, improved varieties, agronomic practices) made a foundation for a renewed Oilseeds Research Project in 1978 following a bilateral agreement between the Governments of Tanzania and the United Kingdom. In the early 1980s, commodity research programs in the country were begun and Agricultural Research Institute-Naliendele became the coordinating center for Oilseeds Research Program (ORP). The ORP has been operating within the framework of the following main objectives:

1. To identify and develop high-yielding varieties adapted to the main growing areas. They should have desirable attributes such as tolerance to insect pests and diseases of major economic importance.
2. To develop the best cultural practices for different varieties of oilseeds.
3. To identify the major insect pests and diseases of economic importance and develop suitable control measures.
4. To investigate the role of oilseeds in farmers' traditional systems and develop recommendations to improve productivity of these systems.

Variety development

The current emphasis of ORP is in the areas of variety development, agronomy, crop protection, socioeconomics, seed multiplication and delivery systems. During 2006 to 2012 the ORP at Naliendele has received significant support from ICRISAT through McKnight CCRP, TL-I and TL-II Groundnut Breeding Projects. Both projects are now in the second phase. To date the ORP has released nine groundnut varieties since its establishment in 1980, five of them through support from TL-II and CCRP projects. The varieties are Nyota-1983, Johari-1985, Sawia-1998 and Pendo-1998 (released before TL-II). With the support of TL-II and CCRP projects, Tanzania NARS released Mnanje-2009, Mangaka-2009, Nachingwea-2009, Masasi-2009 and Naliendele-2009. The most popular variety in the country is Pendo and this has wide adoption in southern Tanzania and in Nanyumbu district has reached ≥90% adoption. Under the present donor funding the newly released varieties Mnanje-2009 and Mangaka-2009 are becoming popular but more efforts are needed to popularize them and for seed bulking.

Constraints to production

The major constraining factors to the production of groundnut in Tanzania include abiotic stresses such as drought, poor soil fertility and poor agronomic practices. The biotic stresses include groundnut rosette disease, early leaf spot and late leaf spot, and foliar rust and aflatoxin contamination of grain. In a study in Tabora region low price, markets, income, inadequate extension services as well as cultivated land size were identified as key elements leading to low production and the following interventions were recommended (Katundu et al. 2012):

1. Increase the market price of groundnut through value addition.
2. Expand the groundnut market demand by establishing small and medium agro-processing units in groundnut growing areas.
3. Provide groundnut producers with credit for purchase of inputs.
4. Appoint extension officers who are specifically hired to cater services for groundnut production. This calls for another research on how to engage extension officers who should specialize in offering services to groundnut producers.
5. Since groundnut production is deemed as women's business, household heads especially men do not give this crop deserved weight for its production. This has mostly contributed to lower production. It was therefore highly recommended to reverse this trend so as to make it a key determinant of household income.

Planned Phase 2 activities and their contribution to national efforts

TL-II Phase 2 aims at delivering new varieties to farmers of Tanzania who have been growing either old or highly susceptible groundnut varieties. The strategy is to intensify R&D efforts to ensure that newly developed varieties have the right traits, for the right agroecology market and home consumption purposes. In Tanzania the project will focus on Objective 2.

Objective 2. To enhance groundnut productivity and production in drought-prone areas of Tanzania

A breakdown of the major activities by objective are presented below.

1. Full operationalization of groundnut breeding program (participatory variety selection, demonstrations, nuclear and breeder seed production)
2. Development of new high-yielding varieties
3. Activities for farmers, technical and professional staff to upgrade skills and awareness

Project results: The expected outcomes and outputs

Expected outcomes

The focus areas of operation for TL-II Phase 2 are in four major groundnut producing regions – Mtwara, Dodoma, Tabora and Shinyanga. The above activities will significantly contribute to the national efforts in terms of development of new varieties with high-yielding potential and availability of the released varieties to the end-users, the farmers. Hence the efforts undoubtedly will increase production and raise national productivity of groundnut in Tanzania from the average of 721 kg ha^{-1} to 820 kg ha^{-1} by 2016 and increase adoption rate by 20% for newly released varieties that are high yielding and resistant to foliar diseases.

Expected outputs

These will focus mainly on delivering products and services:

1. Production of foundation seeds and strengthening breeder seed production through involvement of other partners in the seed value chain.
2. Enhancing seed delivery to increase diffusion and marketing of seeds.
3. Capacity building of seed producers and agro-seed dealers.

Agroecologies/regions for groundnut production in Tanzania

Groundnut is produced throughout the country but the following are the major production zones: Southern Tanzania (Mtwara, Masasi, Nanyumbu), Central (Dodoma, Bahi, Chamwino, Kongwa), Western (Tabora, Kigoma), Lake Zone (Mwanza, Shinyanga), Northeastern (Kilimanjaro, Arusha) and Eastern Zone (Morogoro). Groundnut is treated by most farmers as a cash crop; hence approximately 75% of the harvest is disposed off to the local market and the remaining for household consumption (Mponda et al. 2011). Dominant varieties in Tanzania are Pendo and local varieties in the South and Pendo, Johari and local varieties in Central zone. The rest of the country is dominated by local varieties. Based on 2009/10 data of Ministry of Agriculture Statistics Division, Lake Zone is the leading groundnut producing zone (30%) followed by Western (14%), Southern (12%), Central (8%) and Southern Highlands (7%).

Seed systems for a legumes green revolution in Tanzania

Increasing seed production and its delivery to farmers has been identified as crucial for increasing productivity of all crops including groundnut. Total improved seed requirement for groundnut for Tanzania is about 120,000 tons per annum, but currently the seed going to the market is about 20,000 tons which is equivalent to 16.7% of the total requirement. As such, most farmers are compelled to use farmer-saved seed for planting in their fields which always give poor yields leading to marginal production and productivity per year. On the other hand, local seed production is 2,000 to 6,000 tons per annum and most of the seeds which are used in the country are imported. The imported seeds are not in all cases of good quality and do not meet the agroecological requirements of the country.

The private sector has been reluctant to produce legume seeds because of low profitability. However, legumes constitute the major source of protein to the bulk of the population in Tanzania and SSA. With the above 20,000 tons that is traded in the market, grain legume contribution could be less than or equal to 1%. Grain legumes have no well defined and developed markets for seed and the legumes research team in Tanzania has recommended the need to adopt seed value chain approach by linking producers, processors and consumers and that linkages between legume breeders, Agricultural Seed Agency (ASA), Tanzania Official Certification Institute and other partners in the seed chain need to be effective in order to move the legume seeds forward. At Naliendele, the groundnut breeding program has piloted “The Groundnut Seed Systems Pathway”. The approach is a participatory seed production and delivery model that has helped to increase the awareness and use of improved groundnut and sesame seeds in southern Tanzania. Under TL-II, the groundnut value chain in Tanzania will be used. The participatory seed model adopted in southern Tanzania builds on rural seed fairs that have capacity to create awareness and effective demand for seed in rural areas. The seed fairs are then strengthened by involvement of farmer research groups who participate in the PVS. Experienced groups, farmers and local institutions are then contracted to produce quality seeds by ASA under the coordination of Naliendele Agricultural Research Institute (NARI). Tanzania Official Certification Institute certifies the seed produced at the request of ASA and NARI. The seed delivery chain involves

District Councils, NGOs, Agricultural Marketing Cooperatives, primary cooperative societies, individual farmers purchasing seeds from NARI, ASA, farmer groups and agro-dealers shops.

Strategic partners and their roles

Undertaking R&D with strong impact orientation requires strategic partnerships with a host of partners. These partners will be needed to improve functionality of the value chains. The diverse partners and their roles are presented in Table 1.

Table 1. Strategic partners and their role.

Partner	Role
TOSCI (Tanzania Official Seed Certification Institute)	Variety release, seed certification services and quality control
ASA (Agricultural Seed Agency)	Seed systems support, help collaborating NGOs and CBOs with quality seed production/monitoring
Department of Research and Development (DRD), Ministry of Agriculture and Food Security	Variety development, evaluation and release; production of breeder and foundation seeds
Department of Agricultural Extension Services	Provision of guidance in crop production technologies and associated packages
Farmers	Users
District Council and local Government Cooperative Unions, Agricultural Marketing Cooperatives (AMCOS), Primary cooperative societies	Capacitate farmers formation of associations for collective production and marketing
NGOs – KMAS, Masasi High Quality Farmers, DCT, DMT, ROSDO	Facilitate grassroots development through provision of inputs and technologies
ICRISAT	Provides improved groundnut germplasm; capacity building through training; research on effective methods for technology dissemination
Private sector (market intermediaries and emerging small-scale seed enterprises and processors)	Processing and commercialization of seed and products

Seed production plan

Groundnut seed production plan for Tanzania is presented in Table 2.

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Table 2. Seed delivery plan to cover 20% of the national area under groundnut.

				Breeder seed 2012		Foundation seed 2013		Certified seed 2014	
Ecology (Zone)	Area (ha)	Promising varieties	Area (ha)	Area (ha)	Production (t)	Area (ha)	Production (t)	Area (ha)	Production (t)
Northern	24,780	Pendo	2,480	2.44	2.2	30.00	45	600.00	900
		Mnanje	1,488	1.33	1.2	26.67	40	200.00	300
		Mangaka	496	0.44	0.4	6.67	10	233.33	350
		Nachingwea	496	0.22	0.2	3.33	5	133.33	200
Total			4,960	4	4	67	100	1,167.00	1,750
Central	65,650	Pendo	6,565	0.56	0.5	23.33	35	100.00	150
		Mangaka	2,626	0.28	0.3	20.00	30	100.00	150
		Mnanje	3,939	0.28	0.3	10.00	15	90.00	135
Total			13,130	1	1	53	80	290.00	435
Eastern	5,990	Pendo	599	2.78	2.5	20.00	30	800.00	1200
		Nachingwea	240	1.11	1	10.00	15	333.33	500
		Mnanje	360	1.67	1.5	6.67	10	300.00	450
Total			1199	5.56	5	37	55	1433.33	2150
Southern	88,400	Pendo	8,840	2.22	2	73.33	110	433.33	650
		Mnanje	3536	0.33	0.3	20.00	30	233.33	350
		Mangaka	3536	0.33	0.3	20.00	30	300.00	450
		Masasi	1768	0.44	0.4	20.00	30	166.67	250
Total			17,680	3	3	133	200	1,133.00	1,700
Southern Highlands	78,280	Pendo	7828	1.67	1.5	20.00	30	200.00	300
		Nachingwea	1566	0.33	0.3	10.00	15	166.67	250
		Mnanje	6262	0.22	0.2	6.67	10	133.33	200
Total			15656	2	2	37	55	500.00	750
Lake	156,590	Pendo	15,659	1.44	1.3	23.33	35	200.00	300
		Mnanje	9395	0.33	0.3	10.00	15	133.33	200
		Masasi	6264	0.39	0.4	6.67	10	133.33	200
Total			31,318	2	2	40	60	467.00	700
Western	90,460	Pendo	9,046	1.44	1.3	26.67	40	216.67	325
		Mnanje	5428	0.44	0.4	6.67	10	200.00	300
		Masasi	3618	0.39	0.4	10.00	15	133.33	200
Total			18,092	2	2.1	43	65	550.00	825
Grand total	510,150		102,035	21	19	410	615	5,540.00	8,310

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Cowpea

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Introduction

Importance of the crop in Tanzania

Cowpea is one of the major legumes in Tanzania grown mainly by smallholder farmers, especially women, providing opportunity to lift a large number of farmers out of food and nutrition insecurity and poverty. It is nutritious (high protein content), thrives under low rainfall and poor soil fertility conditions, and can be grown with low capital investment. Cowpea is an important component in Tanzania's cropping system making an important contribution to soil fertility – the major limiting factor to crop productivity in Tanzania's mainly cereal-based cropping system. It is grown in the drought-prone regions of Tanzania and is mostly intercropped with maize. Both grains and tender leaves are consumed. About 63,000 tons is produced annually on 150,000 ha (Fig. 1). Production of cowpea increased at annual rate of 3.4% between the periods from 1985–87 to 2005–07. Projected rate of growth (ROG) in demand is estimated at 4% between 2010 and 2020.

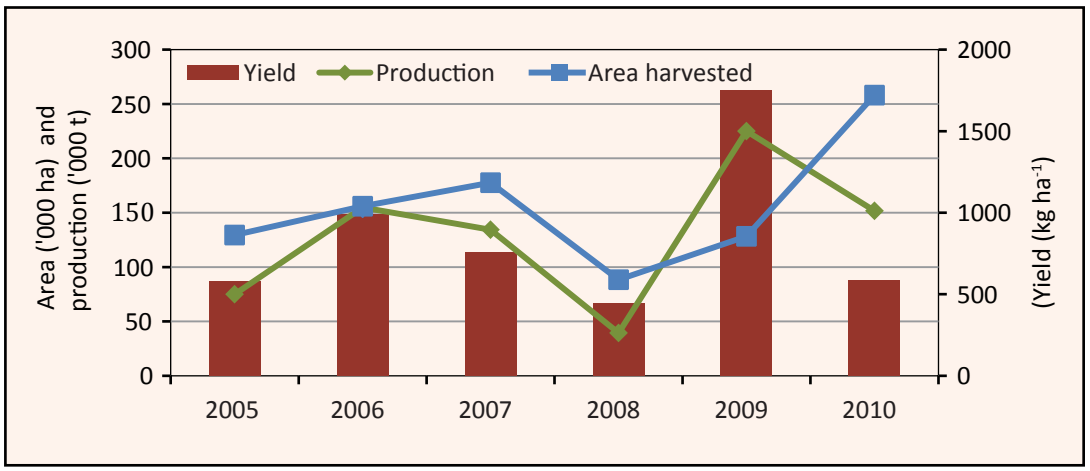

Figure 1. Cowpea area, production and yield in Tanzania during 2005 to 2010 (Source: MoA 2010).

Cowpea's contribution to national GDP, farmer income, food and nutrition security

Cowpea offers higher potentials for food security to the poor as it can be grown in dry areas where most staples (particularly cereals and root and tubers) do not perform optimally. Cowpea is a source of cheap protein and amino acids as compared to cereals. Both the overall demand and supply for cowpea grain in SSA are projected to grow at about 5% per year. The ROG in demand predicted for Tanzania is 3.4%. Data for cowpea trade are not available, but it is possible that almost all of the cowpea produced in Tanzania is used for local consumption. That means cowpea contribution to national GDP is neglected. The economy of Tanzania is overwhelmingly agricultural; in 2006 it contributed 44.7% of the GDP (Source: URT 2007). It relies on smallholder production of crops such as maize, rice, coffee, cotton, cashew and tobacco. Crops such as tea, sisal, and sugarcane are grown in both small and large farms. Other crops which are grown by small-scale farmers include wheat, millets, sorghum, vegetables, banana and cassava. However, only a few crops such as coffee, sisal, tea and sugarcane are grown on large-scale commercial farms. According to a World Bank report (2000), agriculture supports

about 90% of the population living in rural areas. As the urban population in Tanzania is increasing at the rate of 8% per annum, the agriculture sector is expected to increase market output of food crops in order to support the growing urban population (Source: URT 1999). Cowpea consumption is estimated at 14 kg per capita per year.

Research and development

Variety development

Conventional breeding has been in place since four decades. Cowpea breeding is conducted mainly by the Agricultural Research Institute at Ilonga. The cowpea program has the responsibility to conduct research activities including breeding, agronomy and crop protection. The main objective of the cowpea breeding program is to develop high-yielding varieties with drought tolerance and *Alectra* resistance. Several varieties were released by the cowpea breeding unit, which has a harmonious collaborative relationship with IITA's cowpea breeding unit (Table 1).

Table 1. Characteristic features of common varieties developed by the Tanzanian research system.

Official name of release	Year of release	Source of the materials	Genetic background (parentage, pedigree, ancestry)	Area of potential coverage (ha)	Area of actual adoption estimate (ha)	Spillover national boundaries	Average yield potential on-farm (kg ha^{-1})	Varietal traits (selected characteristics)
Tumaini	1982	IITA	TKx9-11D	52,154.7	27,374.3	Yes	800	Indeterminate growth habit, medium seed size with tan color, resistant to cowpea mosaic virus and intermediately resistant to bacterial blight
Fahari	1982	IITA	TVx19-1801F	42,112	19,250.5	Yes	800	Better yield, cream seed color, resistant to cowpea aphid borne mosaic virus
Vuli 1	1987		CROSS 1-6E-2	33,204	10,000		1,000	Red seed color, better yield and resistant to cowpea mosaic virus and intermediately resistant to bacterial blight
Vuli 2	2003	IITA	IT85F 2020	34,500.3	20,200	Yes	1,000	Better yield and white/cream seed color, moderately susceptible to pests, resistant to bacterial blight and cowpea mosaic virus

Major constraints to cowpea production in Tanzania

The major constraints to cowpea production in Tanzania include social, biological, physical and technological environments. Accordingly the major constraints are:

- Biotic stresses: Insect pests (aphids, flower thrips, pod sucking bug, *Maruca,* bruchids), diseases (bacterial, viral and fungal) and *Alectra*
- Abiotic stresses: Drought, heat, low soil fertility
- Poor access to inputs (seed of improved varieties and other agricultural inputs) and output markets (a general lack of market information, poor cultural practices)

- Lack of harvester, thresher, grading and planter machines at affordable level
- Lack of credit

Planned Phase 2 activities and their contribution to national efforts

In TL-II Phase 2 we plan to bring about a mega impact approach where available cowpea technologies would be implemented in most but important cowpea production environments or agroecologies. We are projecting to officially release farmer-preferred drought tolerant lines (IT00K-1263 and ITK99K-1122), at least one variety by 2013. Seeds of six varieties will be produced for use in pair-wise demonstrations in collaboration with farmers. Farmers' varieties will be included in the pair-wise comparisons to be carried out in 10 new communities. One stakeholders' workshop was held before planting and a second one at maturity/harvest time. New crosses involving adapted varieties and elite sources of *Alectra*/drought resistance/tolerance in Tanzania will be generated. The plan set at the end of the phase is to achieve productivity of cowpea of more than 1 t ha^{-1} in intervention areas and to influence the national productivity from 0.5 in 2012 to 0.8 t ha^{-1} by 2014.

Expected outcomes from Phase 2 cowpea improvement for production and productivity

Cowpea farmers and farming practitioners will have higher income. The national cowpea production will increase more than 80,000 tons by 2014 and with productivity of 0.8 t ha^{-1}. There would be excess production over the national demand which should allow for export to other countries.

Agroecologies for cowpea cultivation in Tanzania

Cowpea is grown mainly in mid altitude agroecologies of Tanzania (Fig. 2). The characteristics of the major agroecologies are given in Table 2. There are several regions with cowpea occupying more than 8,000 ha and there are regions with average productivity level greater than 0.6 t ha^{-1} (Fig. 3).

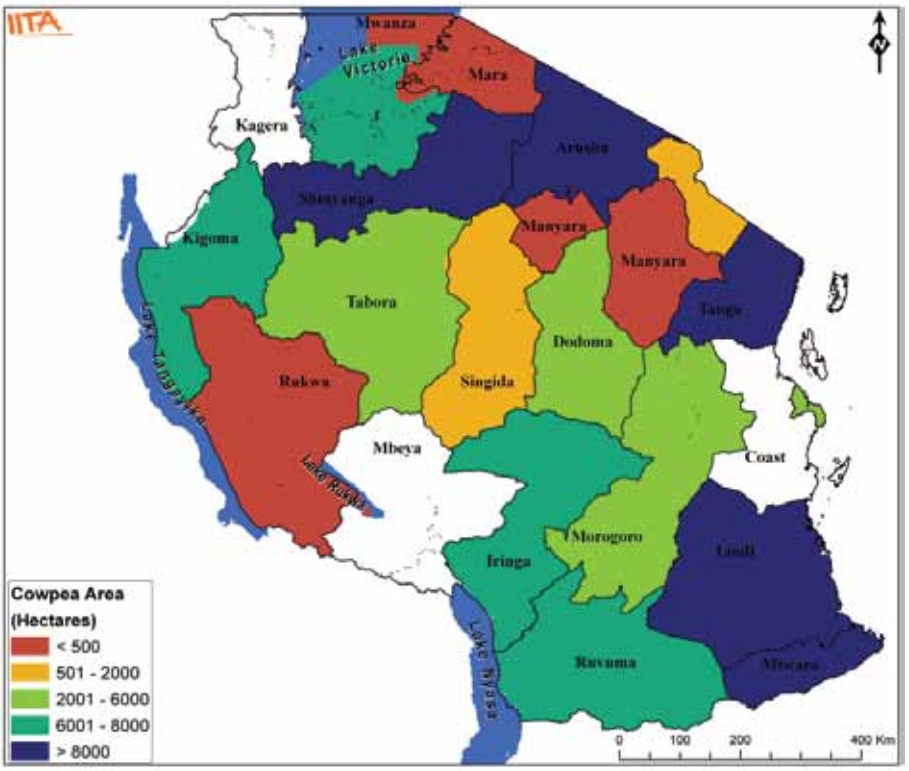

Figure 2. Cowpea production areas in Tanzania.

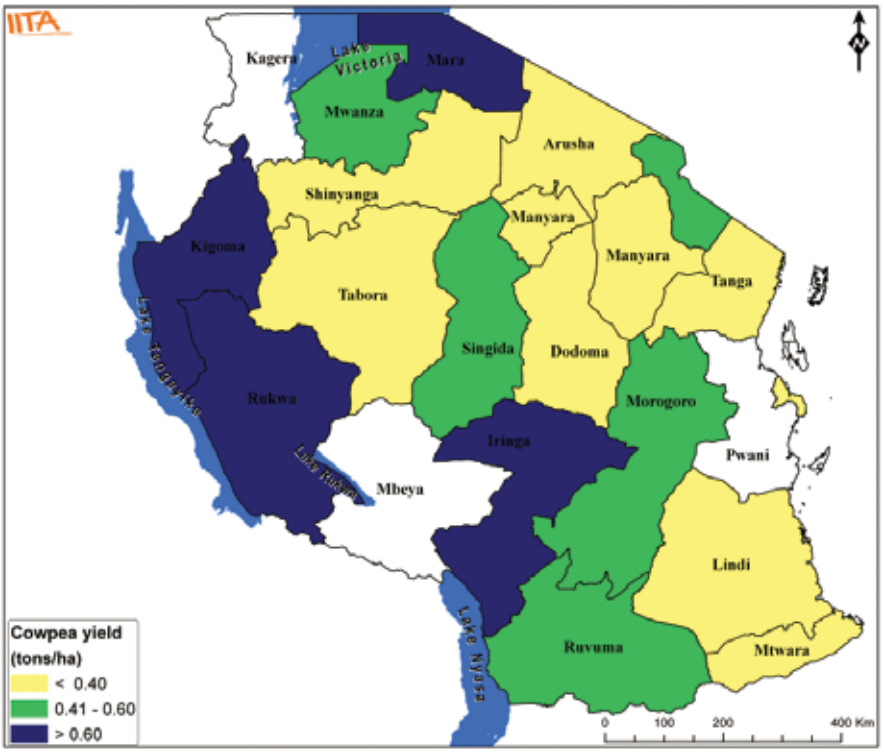

Figure 3. Cowpea yield distribution in Tanzania.

Table 2. Characteristics of agroecological zones (AEZ) of Tanzania.

AEZ	Characteristics
Eastern	Altitude 50 to 1000 m amsl; rainfall 600 to 1200 mm per year, temperatures 20°C to 30°C; soils vary with physiography, sandy along the coast and clayey in the eastern plateau and mountain blocks, shallow to very deep, well and poorly drained.
Western	Latitude 4 to 7° South and longitude 31 to 34° East; temperatures range from a mean minimum of 16.6°C in June to mean maximum of 37.7°C in October; soils are 80–90% sand (Ferric acrisol), with low organic carbon ranging between 0.4 and 0.8%; altitude is about 1199 m amsl, rainfall ranges from 700 to 1000 mm and the rainy season is followed by a long dry season (5 to 6 months).
Northern	Altitude ranges between 900 and 1600 m amsl. It is cut through the middle from North to South by the Rift Valley. Temperature ranges from 13°C to 25°C, and the seasons are wet and dry seasons. Latitude 3.3667 S and longitude 36.6833 E. Major soils in the subhumid uplands include Eutric Andosols, Mollic Fluvisols and Alic Andosols. Dominant soils of the semi-arid lowlands include Eutric Nitisols, Haplic Cambisols and Calcic Vertisols.
Southern	Altitude 100 m amsl; annual rainfall 500 to 900 mm; soils have a wide range, sandy and clay; temperature 20°C to 30°C.
Southern Highlands	70° to 90° South and 300° to 380° East; area 245,000 km^2 (28.5% of mainland Tanzania). Altitude ranges from 400 to 3000 m amsl; annual rainfall ranges from 600 mm (in some parts) to over 2600 mm on the mountains and along Lake Nyasa. The climate varies from tropical to temperate; rainfall pattern is unimodal, with the rainy season starting in October/November through April/May. Most soils are well drained and generally fairly heavy but tend to be acidic with low to medium levels of nutrients and low organic content.
Lake	Altitude of 1198 m amsl; longitude of 33° 01'E and latitude of 02° 42'S. Temperatures range from 15.4°C to 29.1°C. Rainfall unreliable, bimodal and ranges between 750 mm in dry areas and 1,200 mm in wet areas. Soils can be classified into three major groups: (a) sandy soils derived from granite, (b) red loams derived from limestone, and (c) block clay soils.
Central	The central zone is a plateau between 1000 and 1500 m amsl. Annual rainfall varies between 500 and 800 mm. Consists of gently undulating plains with some rocky hill and low scarps associated with the formation of the rift valleys. Soils include well drained sands of low fertility on the uplands and alluvial hard pan.

Seed systems for a legume's green revolution in Tanzania

Seed system is a well established entity in Tanzania since the early 1980s. Agricultural Seed Agency (ASA), Tanseed, NGOs and seed companies are the institutions serving the seed production in the cereal-based cropping system. As a business institution, the enterprise works with cereals (maize, rice, sorghum and pearl millet) and to a limited extent some legumes. Therefore the major actors in the seed system of cowpea are the informal seed sector (seed grower associations, farmers' unions, individual farmers, etc).

The government has enacted the Agricultural Sector Development Strategy (ASDS) to create a favorable environment for commercial activities; delineate public/private roles including continued public financing for core agricultural services with increased private delivery through contracting arrangements; decentralize service delivery responsibilities to local governments; and focus on the preparation and implementation of District Agriculture Development Plans. Seed production is being promoted and producers are being linked to agro-dealers.

Tanzanian seed system strategy (2012–14)

With all functional key stakeholders in place, the seed production (informal seed system dominated) strategy of cowpea in Tanzania is given below.

Area: 129,558 ha

Seed rate (mean): 20 kg ha^{-1}

National demand: 2,591 tons (2012–14)

Capacity to deliver 20% total area: 25,912 ha $\simeq$ 518 tons

Target of productivity: 1 t ha^{-1} at intervention sites and 0.8 t ha^{-1} at national level

Total production target: >108,800 tons

Opportunities, constraints, partnership and seed production

The opportunities, constraints, partnership and plan of the seed required to cover 20% of each important cowpea agroecology in Tanzania with improved seed are discussed.

Opportunities

- Good market setup for cowpea in general and cowpea seed in particular
- Policy environment that enhances innovative seed system
- Availability of suitable varieties in the major growing areas
- Sufficient land mass suitable for cowpea (millions of ha)
- High consumption level/culture in the country

Constraints

- Drought
- Lack of farmer/market preferred improved varieties
- Field and storage pests (bruchids)
- Seed availability
- Lack of awareness (the new varieties are not known to many farmers)
- Susceptibility to notorious weeds (eg, *Alectra*)

Partners

The key partners and their role are given in Table 3.

Table 3. Patners and their role.

Partner	Role
Department of Research and Development (DRD), Ministry of Agriculture and Food Security, ARI-Ilonga, SUA	Variety development, evaluation and release; production of breeder and foundation seed
IITA	Provides improved legume germplasm/breeding populations; capacity building through training; research on effective methods for technology dissemination
Farmer cooperatives	Seed production and dissemination
NGOs (Dioceses, CARE, World Vision, CRS, Africare, WVI), KMAS, Dutch Connection District Councils	Facilitate introduction of new varieties; development of legumes market value chain; resource contribution; informal seed production and dissemination of proven technologies
Private sector in Lake Zone	Processing and commercialization of seed and products
Farmers	End-users of technologies in terms of high-yielding varieties and management practices
Tanzania Official Seed Certification Institute (TOSCI)	Variety release, seed certification services and quality control
Agricultural Seed Agency (ASA)	Seed systems support, helping collaborating NGOs and CBOs with quality seed production/monitoring
Department of Agricultural Extension Services	Provision of guidance in crop production technologies and associated packages

Seed production plan

Cowpea seed production plan for Tanzania is presented in Tables 4 and 5.

The seed delivery will be handled mainly in a Quality Declared Seed (QDS) under supervision of ASA. The higher demand will then be satisfied by seed growers that eventually grow along with the technology promotion. And by 2014 at least 50% of cowpea farmers at national level will get seed access through the informal seed system arranged already at accessible points in a decentralized way. Effective monitoring and support to validate seed quality in a decentralized manner will be served by ASA, mandate research centers, TOSCI and the extension services affiliated to that seed scheme in a contractual agreement.

Table 4. Cowpea seed production in Tanzania from 2012 to 2014.

			Breeder seed in 2012		Foundation seed in 2013		Certified seed for use in 2014	
Agroecology (Demand ha)	Variety (Demand %)	Yield (kg ha^{-1})	Area (m^2)	Production (kg)	Area (ha)	Production (t)	Area (ha)	Production (t)
Eastern (54792)	Tumaini (30)	1500	77.93	11.69	0.58	0.87	43.83	65.75
	Fahari (20)	1400	63.90	8.95	0.45	0.63	31.31	43.83
	Vuli-1 (15)	1700	26.77	4.55	0.23	0.39	19.34	32.88
	Vuli-2 (35)	1800	52.61	9.47	0.47	0.85	42.62	76.72
Western (16796)	Tumaini (80)	1500	63.70	9.56	0.48	0.72	35.83	53.75
	Vuli-2 (20)	1800	9.22	1.66	0.08	0.14	7.46	13.43
Southern	Tumaini (60)	1500	61.14	9.17	0.46	0.69	34.39	51.59
Highlands (21495)	Fahari (40)	1400	50.13	7.02	0.35	0.49	24.57	34.40
Southern (28465)	Fahari (30)	1400	49.79	6.97	0.35	0.49	24.40	34.16
	Vuli-1 (20)	1700	18.54	3.15	0.16	0.27	13.40	22.78
	Vuli-2 (50)	1800	39.05	7.03	0.35	0.63	31.63	56.93
Northern (2514)	Vuli-1 (24)	1700	1.96	0.33	0.02	0.03	1.42	2.41
	Vuli-2(38)	1800	2.62	0.47	0.02	0.04	2.12	3.82
	Tumaini (38)	1500	4.53	0.68	0.03	0.05	2.55	3.83
Lake (27476)	Tumaini (33)	1500	42.98	6.45	0.32	0.48	24.18	36.27
	Vuli-1 (28)	1700	25.05	4.26	0.21	0.36	18.10	30.77
	Vuli-2 (39)	1800	29.40	5.29	0.26	0.47	23.81	42.86
Central (10430)	Tumaini (25)	1500	12.36	1.85	0.09	0.14	6.95	10.43
	Fahari (17)	1400	10.34	1.45	0.07	0.10	5.07	7.10
	Vuli-1 (22)	1700	7.47	1.27	0.06	0.10	5.40	9.18
	Vuli-2 (36)	1800	10.30	1.85	0.09	0.16	8.34	15.02
Total			659.80	103.12	5.16	8.13	406.72	647.87

Table 5. Certified seed production (t) plan over three years.

Variety	2012	2013	2014
Fahari	40	80	119.48
Tumaini	80	170	221.61
Vuli-1	30	70	98.01
Vuli-2	70	150	208.78
Total	220	470	647.87

Vision of success for cowpeas in Tanzania

Highest productivity level (>0.8 t ha^{-1}) will be attained at national and global levels that attributes to the wealth of producer farmers with significant contribution to the home food consumption. The overall production will satisfy the national demand and contribute to the GDP with significant amount for exports and/or agro-processed products.

Common bean

Sostene Kweka, Michael Kilango, Magdalena Williams, Jean-Claude Rubyogo and Steve Beebe

Introduction

The agriculture sector of Tanzania accounts for 46.2% gross domestic product (GDP); food crops contribute 65% of the agricultural GDP. In Tanzania, agriculture grew only by 4% per year in the last decade while the population growth was 3% to 4%. The growth rate in agriculture was low to bring significant improvement in income of people (Source: Policy forum 2009).

Common bean (*Phaseolus vulgaris*) together with maize and rice are the major food crops of smallholder farmers in Tanzania. It is the leading leguminous crop, accounting for 78% of land under legumes. Per capita bean consumption is 19.3 kg, contributing 16.9% protein and 7.3% calorie in human nutrition (Source: Rugambisa 1990) and 71% of leguminous protein in diets (Source: Grisley 1990). It is estimated that over 75% of rural households in Tanzania depend on beans for daily subsistence (Source: Xavery et al. 2006, Kalyebara and Buruchara 2008). The crop residues are used as livestock feed and source of organic matter to enhance soil fertility.

About 1.25 million ha of bean are planted per year, with the main production areas located in the northern zone particularly the Arusha region, the great lakes region in the west and in the Southern Highlands. Tanzania is the largest producer in Sub-Saharan Africa and the world's seventh largest producer of common bean. The area occupied by common bean is second to maize accounting for nearly 11% of the total cultivated land. Total production is approximately 933,000 tons of production each year, while national demand is estimated at 724017 tons. Hence Tanzania is a net exporter of common bean. The crop is grown by smallholder farmers particularly women under quite diverse farming systems and agroclimatic conditions for both household food requirements and income generation (Source: Bosch 1992).

Common bean production and national demand have been increasing (Fig. 1). The area under bean production has been increasing at an average rate of 11% per annum over the last decade. On the other hand, yield growth rates have been increasing from 0.48 t ha^{-1} in 1970 to 0.77 t ha^{-1} in 2001–07 (Source: Katungi et al. 2010). Greater improvements in productivity are expected between 2014 and 2020.

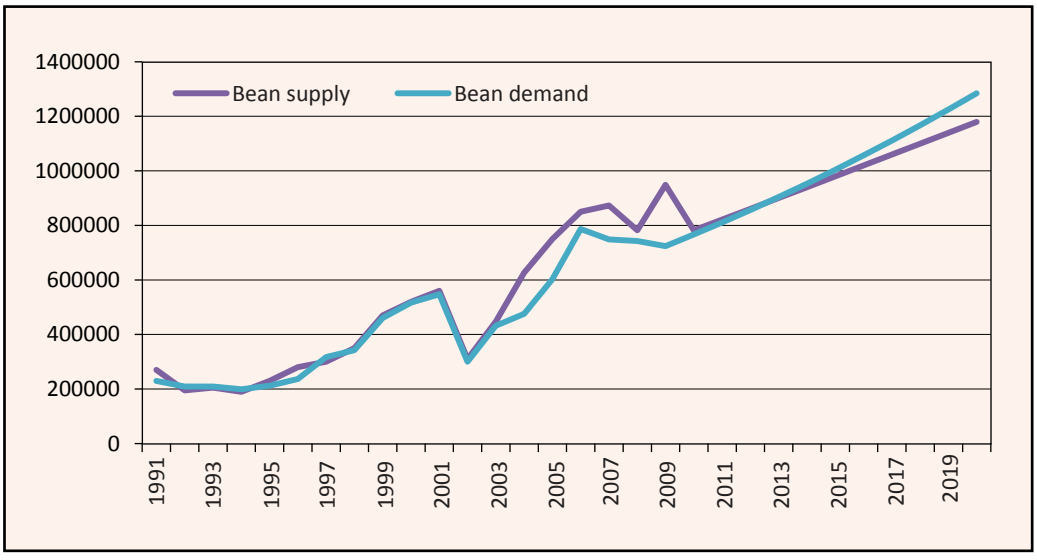

Figure 1. Trends in common bean production (tons) and demand (tons) in Tanzania during 1991–2020 (Source: www.FAOSTAT.org, 2011).

Research and development

The Agricultural Research System in Tanzania is divided into 7 Agroecological Zones: Eastern, Northern, Western, Lake, Southern, Southern Highlands and Central Zones. Each zone has specific mandate crops depending on the zone priorities (Fig. 2). However, during the colonial period, the main emphasis was on cash crops. Research on the main food crops, including beans, gained importance after independence. The Bean Research Program of Tanzania was formally initiated in 1977 though bean research work begun as early as 1965.

The current overall objective of agricultural research and development in Tanzania is to promote sustainable food security, income generation, employment, growth and export enhancement by developing and disseminating appropriate and environment friendly technologies, with emphasis on sustainability of production systems and maintaining the productivity of natural resources. Bean research contributes to this goal through engaging in breeding and research on integrated crop management (ICM) for higher productivity. Bean research in Tanzania has been conducted in close collaboration with the International Center for Tropical Agriculture (CIAT) which started as early as 1973 (Source: Hillock et al. 2006). Varieties released since 1975 are listed in Table 1.

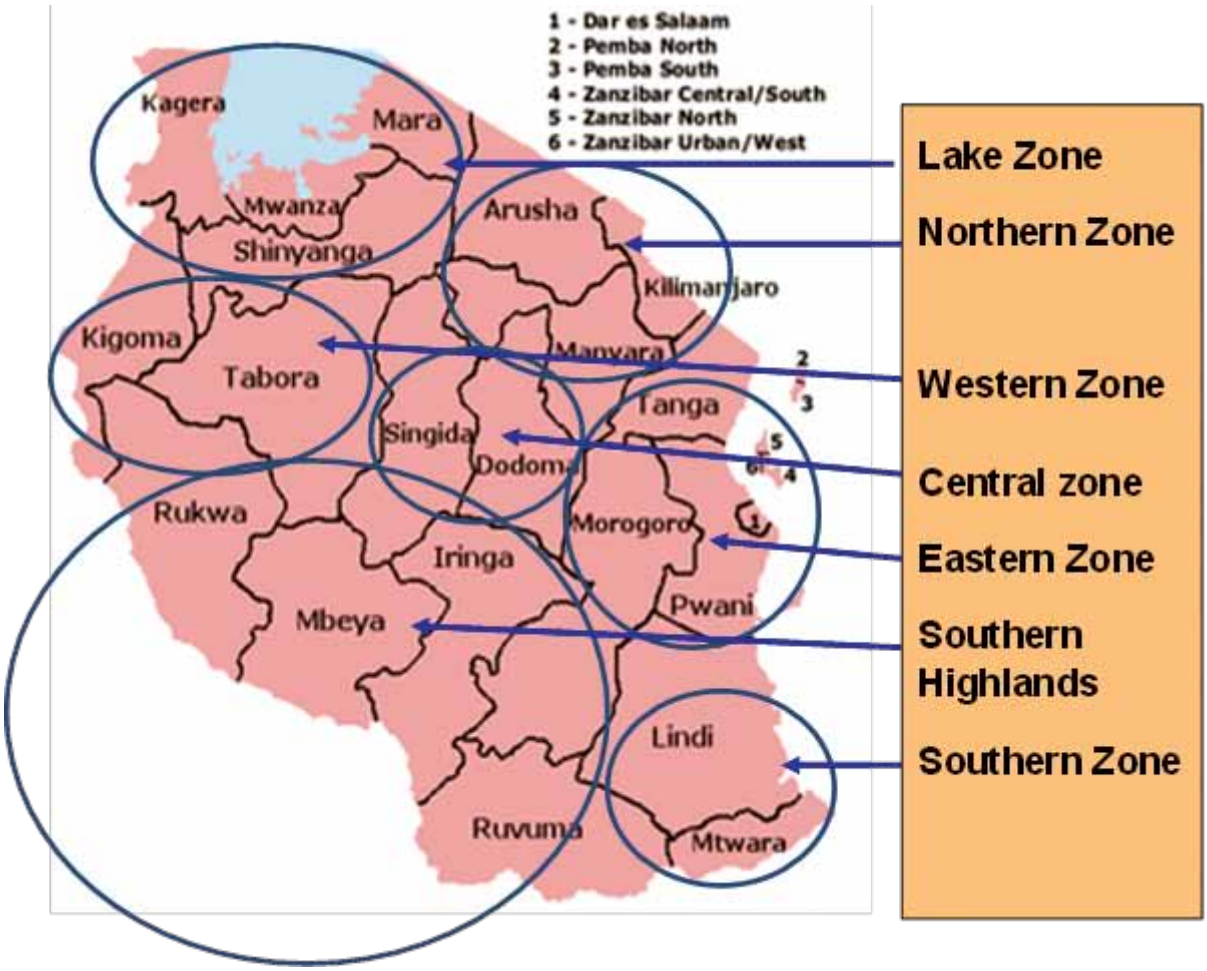

Figure 2. Common bean production zones of Tanzania.

Table 1. Common bean varieties released in Tanzania since 1975.

Variety	Year released	Origin ID code	Yield potential (t ha^{-1})	Area planted (%)	Seed type	Characteristics
Kabanima	1975		2.1	3.6		
Lyamungu 85	1985	CIAT bank (=T23)	2–2.5	8	Large, red/brown, Calima type	Tolerant to drought and diseases
Lyamungu 90	1990	CIAT bank, Colombia bank G 5621	2–2.7	8	Large, red mottle, Calima type	Tolerant to drought and diseases
Ilomba	1990	Local line			Small, brown	
Uyole 90	1990	CIAT	2–2.5		Medium, cream/ brown stripe	
SUA 1990	1990	G 5476	2–2.5		Small, beige	
Selian 94	1994	Tanzania local selection	2–2.5		Medium, pink with red spots	
Uyole 94	1994	Tanzania (=Red kasukanywele)	2–3		Large, cream/ dark red	Tolerant to angular leaf spot and rust
Njano	1996	Introduction = EA1 2525	2–3		Medium, orange	Tolerant to angular leaf spot and rust
Uyole 96	1996	CIAT introduction	2–2.5	6	Large, dark red kidney	Tolerant to angular leaf spot and rust
JESCA	1997	CIAT bank acc. G 14369	2–2.5	5	Large, purple, rounded	Drought tolerant, early maturing
EP4-4 (ROJO)	1997	CIAT bank acc. G 14369			Medium, dark red	
Selian 97	1998	TMO110 × PVA782	2–2.5	2	Large, dark red kidney	
Uyole 98	1999	Bred at Uyole	2–3		Medium, orange	Tolerant to anthracnose, angular leaf spot, halo blight, rust and common bacterial blight
Kablanketi	1999			0.39		
Uyole 03	2003	DRK124	2–2.5	2	Large, sugar type	Tolerant to anthracnose, angular leaf spot and halo blight
Urafiki	2003	Kabanima × GN	2.5–3	2	Medium, dark red kidney	Tolerant to some of the major diseases with quick recovery
Wanja	2003	A197	1.5–2	5	Large, khaki	Escape from stress due to its early maturity
Uyole 04	2004	7068/2	2.5–3	3.72	Medium, cream	Tolerant to anthracnose, angular leaf spot and halo blight
BILFA-Uyole	2004	CIAT	2–2.5	0.39	Medium, Calima	Tolerant to anthracnose, angular leaf spot and halo blight
Calima 2009	2009	PLXCIAT	2–2.5	0.45		Tolerant to anthracnose and angular leaf spot
Kabanima	1979	PI XCIAT	2–2.5		Medium, red mottled	Tolerant to anthracnose, angular leaf spot and rust, early maturing
Uyole 84	1984	Pure local	3–4.5		Small, cream	Tolerant to anthracnose, halo blight, angular leaf spot and common bacterial blight
Calima-Uyole	2011	Others	2–3		Medium, red mottled (Cranberry)	Tolerant to anthracnose and angular leaf spot
PASI	2012		2–3		Large, khaki	Tolerant to angular leaf spot
ROSENDA	2012		2–3.5		Large	Tolerant to angular leaf spot
Fibea	2012		2–3.5		Large, khaki	Tolerant to angular leaf spot

Agroecology

Common bean is widely grown across the country. The highest concentrations are located in the Northern Zone (Kilimanjaro, Arusha, Manyara, Tanga regions), Southern Highlands Zone (Mbeya, Ruvuma, Iringa, Rukwa regions), Lake Zone (Kagera region) and Western Zone (Kigoma) (Table 2). The main growing zones have different rainfall amounts and distribution during the growing season with unimodal distribution (November/December to March/April) in the South, Central and Western zones and bimodal in the northeastern and Lake zones. Bimodal rainfall regions have two seasons, the short season in November/December and long rains from March to May/June.

Table 2. Area under bean production zones and dominant varieties.

Bean production zone	Bean area (ha)	Promising varieties
Northern Zone (Kilimanjaro, Arusha, Manyara, Tanga regions)	370153	Lyamungu 85, Lyamungu 90, Selian 94, JESCA, Selian 97, Selian 05, Selian 06, Cheupe
Southern Highlands and Southern Zone (Mbeya, Ruvuma, Iringa, Rukwa regions)	365661	Wanja, Urafiki, Calima Uyole, Roba1, NRIE27 and PASS
Southern Zone (Lindi and Mtwara)	3683	JESCA
Lake Zone (Kagera, Mara and Mwanza region)	307951	Lyamungu 09, Selian 06, Uyole Nyano
Eastern Zone (Morogoro)	25813	Rojo, Ushindi, Pesa, and SUA 90,
Shinyanga	35168	JESCA
Central Zone (Dodoma, Singida, Tabora)	43269	
Western Zone (Kigoma)	98302	Lyamungu 09, Selian 06, Uyole Nyano
Total	1250000	

Constraints

Biophysical constraints

Major constraints to common bean production are:

- Limited access to genetically high-yielding varieties
- Diseases notably, angular leaf spot, common bacterial blight, common bean mosaic virus, rust, anthracnose, halo blight and root rot
- Insect pests (bean stem maggot, aphids and bruchids)
- Poor soil fertility (low N, low P, Al, Fe and Mn toxicity, low exchangeable bases)
- Terminal drought

Socioeconomic and institutional constraints

- Poor access to inputs (seed of improved varieties, labor, complementary agro-chemicals, land, etc) and output markets (generally lack of market information). This results from poor product grading and standardization; inadequate market infrastructure (high transport cost, high transaction costs and inadequate storage facilities); and unstructured market of inputs and outputs. Consequently, farmers get low farm-gate price due to long value chain and poor quality standards of their produce.
- Low access to extension information; sometimes the desirable varieties are not adopted by farmers due to lack of information or awareness.

- Lack of infrastructure like storage facilities to support growth of long distance trade.
- Lack of credit and inadequate government policy support toward bean crop despite its importance (cash and food/nutritional security especially for the poor and women). Agricultural research in NARS is constrained by low numbers of scientists with the relevant experience and lack of reliable techniques or infrastructure (such as laboratories for screening purpose, irrigation facilities) not adequately provided.

Opportunities

There are ample opportunities to improve the production of common bean in Tanzania.

- The government has enacted the Agricultural Sector Development Strategy (ASDS) to create favorable environment for commercial activities; delineate public/private roles including continued public financing for core agricultural services with increased private delivery through contracting arrangements; decentralize service delivery responsibilities to local governments; and focus on the preparation and implementation of District Agriculture Development Plans.
- The government has adopted the policy of "*Kilimo Kwanza*" as the country's green revolution to transform its agriculture into a modern and commercial sector through investment in both public and private organizations, in rural infrastructure such as roads, irrigation, inputs such as high-yielding seed varieties and fertilizer, and improved technology.
- High priority (Priority 1) accorded to the crop by Government of Tanzania.
- Additional on-going initiatives promoting sustainable intensification of common beans with cereals [SIMLESA, USAID's Feed the Future (FtF) in Tanzania] provide great advantage for synergies for this project.
- Growing bean export market in the neighboring countries and overseas.
- PABRA bean regional networks which provide opportunity of exchange of experience/skills, adapted germplasm and other technologies, and complementary funding.
- Presence of strategic partners/role (Table 3).

Seed systems strategy

In line with "*Kilimo Kwanza*" – green revolution, agriculture sector to grow by 10%. The vision of bean research in Tanzania is to increase bean yields from 0.77 t ha^{-1} to at least 1 t ha^{-1} and increase export earnings from beans as well as its contribution to food security. Bean seed production plan for Tanzania is given in Table 4.

R&D emphasis for TL-II Phase 2

- Develop and introduce effective ICM strategies for common bean production.
- Strengthen research on new introduced drought resistant lines.
- Release and promote improved/preferred varieties.
- Intensify seed production and strengthen community-based seed systems.
- Help to develop plans for commercialization.

Table 3. Partners and their role in the seed system.

Partner	Role
DRD (Department of Research and Development, Ministry of Agriculture and Food Security)	Variety development, evaluation and release; production of breeder and foundation seed.
CIAT[1]	Provide improved common bean germplasm/breeding populations; capacity building through training of NARS; research on effective methods for technology dissemination and provision of financial assistance to NARS to conduct research based on mutual proposed activities between donors and NARS.
Farmer Cooperatives/Groups	Seed multiplication and dissemination.
NGOs (Dioceses, CARE, World Vision, CRS, MVIWATA, FARM AFRICA, MIFIPRO, INCOMET, ADP, KMAS) and District Councils	Facilitate introduction of new varieties; development of legumes market value chain, resource contribution; informal seed production and dissemination of proven technologies.
Private sector: Zenobia Ltd, Meru Agro, International Tanseed Ltd	Processing and commercialization of seed and products.
Farmers	End-users of technologies in terms of high-yielding varieties, management practices and seed multiplication.
TOSCI (Tanzania Official Seed Certification Institute)	Variety release, seed certification services and quality control; collaborating with NGOs and CBOs in Quality Declared Seed (QDS) production/monitoring.
ASA (Agricultural Seed Agency)	Mass seed production of different crops (Basic seed production, Certified seed production, Foundation seed production).
District Councils (Department of Agricultural Extension Services)	Provision of guidance in crop production technologies and associated packages.
ECABREN/SABRN/ WECABREN	ECABREN/SABRN/WECABREN in partnership with customers and diverse research and development stakeholders seeks to contribute to the social welfare and economic growth of the people in East and Central Africa and Southern Africa while protecting natural resource base by providing acceptable and marketable bean based technologies and strengthening institutional capacity to adequately address existing and emerging bean research and development agenda in the region.
Ministry of Agricultural and Food Security (MAFS)	Promote efficient and effective services to the agricultural sector in collaboration with all stakeholders.
Traditional Irrigation Improvement Program	Contribute to a durable and gender-balanced improvement of standard of living of the community in traditional irrigated areas in Tanzania through sustainable development of catchments with regard to irrigation, natural resources management, soil and water conservation, afforestation, participatory land-use planning and organizational development.
Tanzania Food and Nutrition Centre (TFNC)	Formulate, initiate and promote development policies and plans, regulations and legislation for improvement of nutritional status of Tanzania community; promote nutrition of the socioeconomical deprived and nutritionally vulnerable groups; promote community participation in managing and controlling nutritional problems in the country; promote applied and basic nutrition and research; and promote private sector involvement in nutrition intervention.

Continued

Table 3. *Continued.*

Partner	Role
Participatory Agricultural Development and Empowerment Project (PADEP)	The overall development objective of the project is to increase farm incomes and reduce food insecurity, thereby contributing to reduction of rural poverty. The project immediate objectives are to: (i) Strengthen the capacity of rural communities and farmers' groups to plan and implement agricultural development sub projects; and (ii) Strengthen the capacities of rural service providers of Local Authorities and national level to provide more responsive assistance to community and farmers' needs.
Agricultural Marketing Services Development Project (AMSDP)	Strengthen about 1000 producers groups to enable them to have a better bargaining position and more leverage on policy formulation to identify marketing opportunities and to improve price negotiation for both buying and selling products. Establish links among producers groups, grassroots institutions, processors, local marketing chains and exporters.
Tanzania Social Action Fund (TASAF)	TASAF Components: Community Development Initiatives (CDI), Public Works Program (PWP) and Institutional Development (ID) The CDI component will support community demand-driven initiatives that improve the accessibility to and the delivery of socioeconomic services and enhance the capacity of communities and other stakeholders involved in the process. The objective of the PWP, a safety net scheme, is to provide a cash transfer for targeted beneficiaries, while increasing/ improving the infrastructure assets in targeted areas, and enhancing the beneficiaries' skills for future employment.
Mass Media: TBC, ITV, Star TV, Local radio FM	Assist in broadcasting/promoting agricultural based technologies to the end-user.
Agricultural Marketing Systems Development Program (AMSDP)	Facilitate the process of establishing appropriate policies, regulations and legislation, improve market information systems and institutionalize the analysis and monitoring of policy impact at national and local government levels; empower groups of smallholder farmers and small-scale traders/processors and link them with the market; facilitate access to credit by smallholders for storing produce and medium-scale traders and processors for increasing the size and efficiency; rehabilitate and maintain market infrastructure especially rural and village roads. AMSDP coordination unit consulted partner agencies (PA) to facilitate implementation of this developmental program for selected districts in Northern and Southern zones of Tanzania. The Traditional Irrigation and Environmental Development Organization (TIP) is one of the PAs that implements AMSDP in Arumeru district (Northern Tanzania).
Rural Financial Service Program (RFSP)	Improvement of the managerial capacity and performance of grassroots micro-financial institutions (MFIs), the rural financial systems development and the empowerment of the rural poor; monitoring and evaluation and management and coordination. The target group is drawn from the poor households in the 21 program districts. Specifically, the program targets poor rural households including farm households and the landless; community-based organizations (CBOs), Upatu and other solidarity groups, and the rural MFIs that serve them, viz, Savings and Credit Societies (SACCOS) and Savings and Credit Associations (SACAs).
Mtandao wa Vikundi vya Wakulima Tanzania (MVIWATA)	Develop a strong representation of farmers' interests in confronting their own problems mainly on participatory communication, lobbying and advocacy, organizational strengthening in providing agronomic services and marketing strategies.
SUA (Sokoine University of Agriculture)	Bean based technologies; training for degree and non-degree courses.

1. CIAT is an agricultural center, internationally mandated for undertaking bean research.

Table 4. Common bean seed production plan for Tanzania.

Ecology	Seed demand	Desired traits[1]	Varieties	Available breeder and foundation seed (t)	Seed production (t)			Seed to reach 20% adoption (t)	Estimate of seed produced (t)			Key partner	Primary role
					Breeder seed	Foundation seed	Certified seed		2012	2013	2014		
Northern	170000 ha (13,600 tons of seed)	Resistant to anthracnose, ALS, RR, CBB, HB and BCMV	Lyamungu 85	4.2	16	233	3497	3746	937	1311	1498	ASA, TOSCI, Zenobia Ltd, Mviwamo Farmer Groups, Tanseed International, District Councils	Seed production
		Resistant to anthracnose, ALS, RR, CBB, HB and BCMV	Lyamungu 90	3.2	16	233	3497	3746	937	1311	1498	ASA, TOSCI, Zenobia Ltd, Mviwamo Farmer Groups, Tanseed International, District Councils	Seed distribution
		Resistant to anthracnose, ALS, RR, CBB, HB and BCMV	Selian 94	1	16	233	3497	3746	937	1311	1498	ASA, TOSCI, Zenobia Ltd, Mviwamo Farmer Groups, Tanseed International, District Councils	Markets
		Early maturing, resistant to anthracnose, ALS, rust, CBB, HB and BCMV	JESCA	2.5	16	233	3497	3746	937	1311	1498		
		Resistant to anthracnose, ALS, rust, CBB, HB and BCMV	Selian 97	1	7	104	1554	1665	416	583	666		
Southern Highlands	247010 ha (19,761 tons of seed)	Early maturing, resistant to ALS, rust, anthracnose and BCMV	Urafiki	2.3	15.64	234.6	3519	3769	937	1344	1498	ASA, Tumaini University, ARI Uyole Farm, SUBA Seed Co, INCOMET, Kipato Seed Co, Farmers' organization, Southern Highlands seed growers	Seed production
		Tolerant to low soil fertility, can escape the effects of drought by being harvested before the end of rains	Wanja	3.1	15.64	234.6	3519	3769	937	1344	1498		

Continued

Table 4. *Continued.*

Ecology	Seed demand	Desired traits[1]	Varieties	Available breeder and foundation seed (t)	Seed production (t)			Seed to reach 20% adoption (t)	Estimate of seed produced (t)			Key partner	Primary role
					Breeder seed	Foundation seed	Certified seed		2012	2013	2014		
		Resistant to pests (pod borer), fairly tolerant to ALS, anthracnose and rust	Uyole 96	4	15.6	234.6	3519	3769	937	1344	1498		
		Tolerant to low soil fertility, resistant to ALS, CBB, BCMV and rust	Calima Uyole	1	12.5	188.2	2823	3024	756	1058	1210		
		High yielding, tolerant to low soil fertility, resistant to drought	Njano Uyole	4	23.4	351	5270	5644	1361	1976	2258		
		Resistant to anthracnose, rust and BCMV, dense in iron and zinc	Uyole 04	2.5	17.6	263	3952	4233	1058	1482	1693		
		Resistant to ALS, anthracnose and rust	Pasi	0.2	1.3	19	282	302	76	106	121		
		Tolerant to low soil fertility, resistant to ALS, anthracnose, rust and BCMV	NRI-E27	0.2	1.3	19	282	302	76	106	121		
		Resistant to ALS, anthracnose, BCMV, CBB and rust	Roba	0.2	1.3	19	282	302	76	106	121		
Lake zone		High yielding, tolerant to low soil fertility, resistant to drought	Njano Uyole	1.5	55	821.2	12,318	13194	3299	4618	5278	Wapendanao, Sisimuka, Biija mpola, Mshikamano, ONJAMI Kolping Society of Tanzania, Itente, Maisha mapya, Tujikomboe, BRAC and SAFO	Seed production
		Resistant to anthracnose, ALS, RR, CBB, HB and BCMV	Lyamungu 90	1.5	55	821.2	12,318	13194	3299	4618	5278		

1. ALS = Angular leaf spot; RR = Root rot; CBB = Common bacterial blight; HB = Halo blight; and BCMV = Bean common mosaic virus.

Chickpea

Robert Kileo, Ganga Rao and Said Silim

Introduction

Chickpea provides unique opportunity of enhancing legume production in Africa as it does not compete for area with other major legumes being a dry-season (postrainy season) legume. There is not much choice of legumes for growing on the residual moisture in the postrainy season, the conditions and season in which chickpea is grown. Chickpea is indeed a bonus crop in Tanzania. After harvest of maize/rice in Tanzania, the land is normally left fallow until the next cropping season (rainy season). Chickpea is planted immediately after the harvest of cereals and grows on residual moisture thus giving farmers a second crop (where only one crop would traditionally be grown), hence income and nutrition.

The bulk of chickpea produced in Eastern Africa is consumed locally, adding to the nutrition of people; and surplus is being exported to earn foreign exchange. Tanzania exports a substantial amount of its chickpea produced, up to 21000 tons with a value of US$ 7 million. Chickpea has more diversified uses than any other food legume. The green leaves are used as leafy vegetable and are superior to spinach and cabbage in mineral content. The green immature seed is used as a snack or vegetable. Selling green pods for green seed is highly profitable as these are sold around US$ 1 to US$ 1.5 per kg and weigh 2–3 times higher than dry seed. The dry seed splits and flour are used in a variety of other preparations like *githeri*, stew, *mandazi*, cake, *samosa*, doughnuts, buns, *chapati* and grits.

Research and development

Research on chickpea in Tanzania began with seed money from CGIAR-Canada Linkage Fund (CCLF), which allowed the evaluation of large number of accessions and the selection of potential varieties for further testing. The TL-II project (funded by BMGF) gave an impetus to enhance research and through on-farm, farmer participatory variety selection (FPVS) and demonstrations and sustainable seed systems resulted in landmark fast track release of the first set of varieties (Table 1).

The TL-II Project Phase 1 which started in September 2007 and ended in August 2011 focused mainly on chickpea germplasm development, FPVS, varietal dissemination, capacity building, seed multiplication and production. The work was carried out in Shinyanga and Mwanza regions. Overall, TL-II Phase 1 contributed to increased chickpea yields, farmers' income, increased utilization/nutrition and improved livelihoods through (a) availability of improved germplasm that is high yielding and tolerant to fusarium wilt; (b) increased dissemination, up-scaling and adoption of the improved germplasm; (c) infrastructure and capacity building; and (d) increased linkages and partnerships.

Table 1. Characteristic features of varieties released in Tanzania[1].

Variety	Year of release	Pedigree	Potential area (ha)	Average on-farm yield potential (kg ha^{-1})	Varietal traits
Ukiriguru 1 (Desi)	2011	ICCV 97105	29000	1600	Medium seed size, medium maturity (earliness), resistance to fusarium wilt, market opportunities
Mwanza 1 (Desi)	2011	ICCV 00108	36000	1800	
Mwangaza (Kabuli)	2011	ICCV 92318	20000	1900	
Mwanza 2 (Kabuli)	2011	ICCV 00305	18000	1500	

1. Released by Ukiriguru Agricultural Research Institute, Lake Zone, Tanzania.

Agroecologies of chickpea cultivation

Chickpea in Tanzania occupies about 105,000 ha and is mostly grown in Lake, Western and Northern Zones (Table 2).

Table 2. Major chickpea growing areas in Tanzania.

Zone	Regions	Area (ha)
Lake Zone	Shinyanga, Mwanza, Mara, Kagera	80,000
Western Zone	Tabora, Kigoma	15,000
Northern Zone	Arusha, Manyara	10,000
Total		105,000

Seed systems

In Eastern and Southern Africa, baseline studies indicated that very limited awareness existed on improved chickpea varieties, due to consistent failure of public sector to supply good quality source seed and the lack of interest by the private sector to engage in legume seed production; in addition, most often, seed is produced in high potential areas or areas with infrastructure for storage and processing far away from the area of utilization, leading to high transaction costs. Requirements for high seeding rates further limit the spread of new varieties.

To overcome these constraints, investments have been made in breeder and foundation seed production, and proceeds from seed sales were employed to re-capitalize seed revolving funds to support subsequent seed production cycles. Foundation seed has been marketed to private companies and NGOs for further seed production and dissemination. Most of the farmers rely on own-saved seed and access to seed of improved varieties either through informal networks or relief seed. The survey also revealed the existence of two seed supply systems, ie, informal, which is usually non-market based seed supply system and the quasi-formal, mainly market-based seed supply system. The informal seed supply sources included own-saved seed, gifts from family and friends, farmer-to-farmer seed exchanges and others. The importance of quasi-formal supply seems to increase with the availability of new farmer-preferred varieties, which helps in emergence of seed markets for improved varieties.

Seed production target

Total area: 105,000 ha

Seed rate (mean): 90–120 kg ha^{-1} based on seed size

National seed demand: 11,466 tons (2012–14) to cover 105,000 ha

Capacity to deliver 20% total area: 21,000 ha

Total seed required to cover targeted area of 21,000 ha $\simeq$ 2064 tons

Opportunities, constraints, partnerships and seed production plan

Opportunities

- Farmers in the target areas have recognized that chickpea is a drought tolerant crop and hence can be used to mitigate the effects of climate change. Furthermore, most of the improved materials have tolerance to fusarium wilt coupled with early maturity to catch up with the huge Indian market. This creates a big demand for seed of the improved materials.

- There is available market and demand for the seed and grain within and outside the country.
- Few private seed companies have taken up production of seed but due to increase in demand some are now becoming interested to produce quality seed.
- The four new varieties released and their seed availability through sustainable seed systems planned under TL-II, CGIAR Research Program on grain legumes and national level support will contribute significantly to seed availability.
- The country has also embarked on *Kilimo Kwanza* as Tanzania's Green Revolution to transform its agriculture into a modern and commercial sector. Some of its actionable pillars like political will to push agricultural transformation, enhanced financing for agriculture and incentives to stimulate investments in agriculture can support the seed plan.

Major production constraints

- Pests and diseases and their dynamism: Fusarium wilt, collar rot, pod borer, bruchids
- Waterlogging, drought
- Seed supply inadequacy, picking green chickpea, poor cultural practices
- Lack of harvester, thresher, grading and planter machines at affordable level

Key partners

The key partners and their role in the seed system are given in Table 3.

Table 3. Key partners and their roles in the chickpea seed roadmap implementation.

Partner	Role
Research Institutions (LZARDI, SARI)	Germplasm development, variety release, produce breeder seed, dissemination
TOSCI – Tanzania Official Seed Certification Institute	Seed certification and quality control
ASA – Agricultural Seed Agency	Foundation and certified seed production, marketing
ICRISAT-TL-II	Funding, provide improved germplasm, capacity building, facilitate seed production and distribution, up-scaling
Extension services	Advisory services, farmers' mobilization and dissemination
Local government authorities/policy makers	Farmers' mobilization, supportive policy, funding, dissemination/up-scaling
NGOs, CBOs, farmers' associations	Mobilization of farmers, group formation, facilitate access to loans, inputs and markets, advisory services
Agro-dealers	Advisory services, inputs/seed availability, loans to farmers
Seed companies (Kilimo market)	Seed production, marketing and distribution
Contract farmers	Produce quality seed
Individual farmers	Seed buyers and users, grain producers and buyers, dissemination/up-scaling

Seed production plan

The seed production plan for chickpea in Tanzania is presented in Tables 4 and 5.

Table 4. Chickpea seed roadmap for Tanzania.

Ecology (Zone)	Demand (ha)	Promising varieties	Yield potential on-farm (t ha^{-1})	Seed rate (kg ha^{-1})	Total area to be covered (ha)		Breeder seed in 2012		Foundation seed in 2013		Certified seed in 2014		Total seed required to reach 20% adoption (t)
					Zone wise	Variety wise	Area (ha)	Production (t)	Area (ha)	Production (t)	Area (ha)	Production (t)	
Lake Zone	80,000	4			16,000		3.36	5.63	55.7	93.7	936	1584	1584
	24,000	Mwanza 1	1.6	90		4800	0.85	1.36	15.2	24.3	270	432	432
	24,000	Ukiriguru 1	1.8	90		4800	0.6	1.08	12	21.6	240	432	432
	16,000	Mwangaza	1.9	120		3200	0.81	1.54	12.8	24.3	202	384	384
	16,000	Mwanza 2	1.5	105		3200	1.1	1.65	15.7	23.6	224	336	336
Western	15,000	4			3000		0.57	0.93	9.7	16.2	169	282	282
	9,730	Mwanza 1	1.6	90		1946	0.35	0.55	6.2	9.9	109	174	175
	2,270	Ukiriguru 1	1.8	90		454	0.06	0.11	1.1	1.98	23	41	41
	2,270	Mwangaza	1.9	120		454	0.11	0.21	1.7	3.2	27	51	51
	730	Mwanza 2	1.5	105		146	0.05	0.08	0.7	1.1	10	15	15
Northern	10,000	4			2000		0.43	0.71	7	11.6	117	198	198
	3,000	Mwanza 1	1.6	90		600	0.11	0.18	1.9	3.0	34	54	54
	3,000	Ukiriguru 1	1.8	90		600	0.08	0.14	1.5	2.7	30	54	54
	2,000	Mwangaza	1.9	120		400	0.1	0.19	1.6	3.0	25	48	48
	2,000	Mwanza 2	1.5	105		400	0.14	0.21	2.0	3.0	28	42	42
Total	105,000				21000		4.36	7.27	72.4	121.5	1222	2064	2064

Table 5. Certified seed production (t) plan over three years.

Variety	2012	2013	2014
Mwanza 1	99	165	397
Ukiriguru 1	79	132	317
Mwangaza	73	121	289
Mwanza 2	59	98	236
Total	310	516	1238

Vision of success

Based on the calculations made from different sources, chickpea area has increased during the last couple of years. This shows that there is a very big potential for the crop to grow and contribute to the GDP of the country through export. The climate change crisis and good prices offered have forced farmers to adopt the crop in many parts of the country. Recently farmers have started selling green chickpea in the local markets, while a number of agro-dealers are selling quality seed to farmers. Some local restaurants are also serving green chickpea along with or instead of green pea. These are new avenues which can increase demand and success of the crop.

Pigeonpea

Stephen Lyimo, Rose Ubwe, Joseph Mligo, Mishek Makenge, Ganga Rao and Said Silim

Introduction

Tanzania is among the top ten producers of pigeonpeas in the world. The area and production of pigeonpea in the country from 2005 to 2011 are shown in Figure 1. Overall, the area and total production have increased over the years due to expansion but productivity or yield per unit area has not changed much despite use of improved materials due to poor crop husbandry practices and drought conditions.

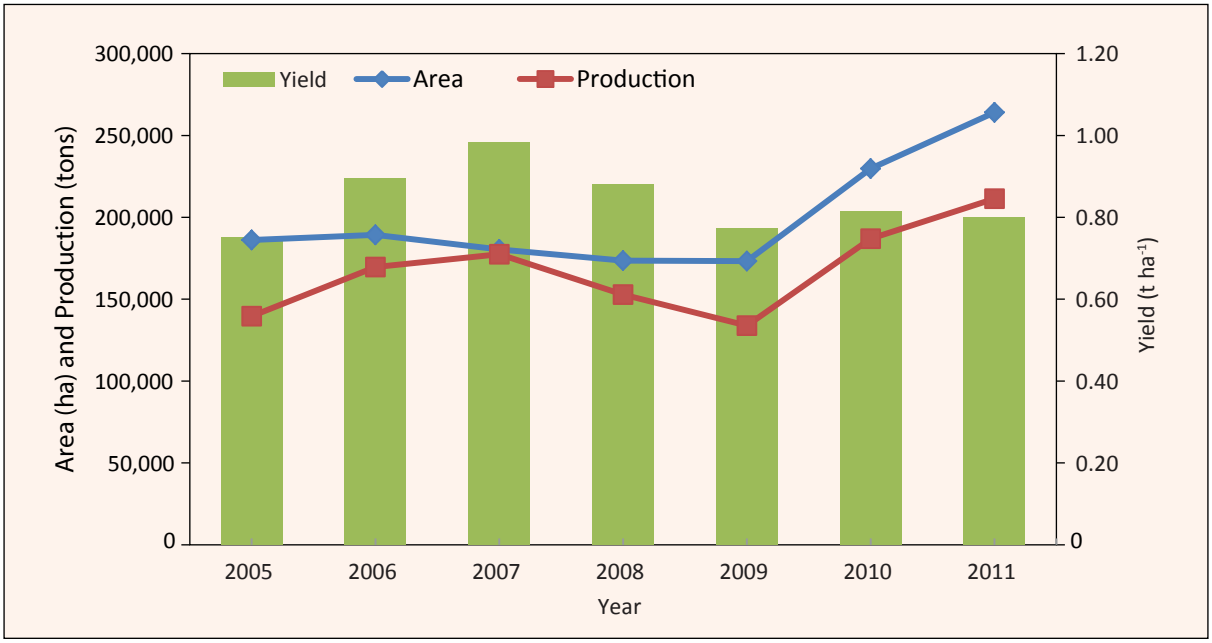

Figure 1. Trends in pigeonpea area, production and yield in Tanzania during 2005 to 2011 (Source: FAO Stats, Statistics Unit-MAFSC, http://www.kilimo.go.tz/agricultural statistics/ Basic Data 2005–2010, district profiles and communication with extension services).

Since 1996/97 to date there have been several pigeonpea projects like PIMASA, TL-II, IFAD, AGRA and recently SIMLESA which were/are being implemented in the Northern, Central and Eastern Zones. These projects contributed a lot to uptake of improved pigeonpea through awareness creation, seed production and distribution. For example, partners in TL-II Phase 1 Project produced and distributed about 270 tons of certified/quality declared seed. A Soil Health Program Project under AGRA also distributed about 32 tons of certified/quality declared pigeonpea seed to farmers in 2010/11 and 2011/12. Such an amount of seed alone could be planted in more than 30,000 ha.

According to Shiferaw et al. (2005), the adoption rate for improved pigeonpea in Babati which is one of the early target areas was about 34%. Field estimates in the same area in 2010 indicated that about 80% of the farmers were planting improved pigeonpea materials. The national adoption rate is however, estimated at about 20%. At the farm level, farmers are being paid an average of about 650–750 TSH per kg grain which is about 40–47 US cents. Farmers who adopted the technology have improved their income and livelihoods by building improved houses, sent their children to schools and colleges, built secondary schools, bought motor bikes/bicycles, bought spare parts for their tractors, started small and medium businesses, bought improved cattle/goats and some agro-dealers are now selling pigeonpeas, etc.

About 60–80% of the pigeonpea produced in the country is sold as dry grain whereas the remaining portion is consumed at household level while green and dry, and some left as "seed" for the following season. However, farmers in Moshi have recently found market for green pigeonpea in Kenya, and have started utilizing the opportunity.

Research and development

Pigeonpea research started in the early 1980s at ARI, Ilonga by collecting and evaluating local and introduced genetic materials from ICRISAT which were suitable and potential for Tanzania. On station and multilocational breeding trials including screening for fusarium wilt resistance were done for early-, medium- and long-duration lines to determine high-yielding and fusarium wilt resistant lines. Agronomic field trials on maize/pigeonpea and sorghum/pigeonpea intercropping were also conducted to determine yield, optimum plant population, spacing and time of sowing.

Collaborative research work for the crop started in the 1990s with different partners in the Northern, Eastern and Lake Zones. The key partners were extensionists, local government authorities, Sasakawa Global 2000, ICRISAT, TechnoServe, contract farmers, farmers' groups, private seed companies/estates, NGOs, the Agricultural Seed Agency (ASA) and the Catholic Relief Services (CRS). The main focus in the research was participatory variety testing/selection, establishing sustainable seed supply systems through private sector contract farming, screening for fusarium wilt, improved management practices, and initiatives to enable farmers to access local and external markets through formation of Producer Market Groups (PMGs). Three improved pigeonpea varieties released in Tanzania are listed in Table 1.

Table 1. Improved pigeonpea varieties released in Tanzania.

Variety/Line	Year released	Maturity period
Komboa (ICPL 87091)	1999	Short duration (110–120 days)
Mali (ICEAP 00040)	2002	Long duration (180–270 days)
Tumia (ICEAP 00068)	2003	Medium duration (140–180 days)

The TL-II Project Phase I, which started in September 2007 and ended in August 2011 focused mainly on pigeonpea germplasm development, farmer participatory variety selection (FPVS), varietal dissemination, capacity building, seed multiplication and production. The work was carried out in Kilosa, Babati and Karatu districts in Morogoro, Manyara and Arusha regions respectively. Overall, TL-II Phase 1 contributed to increased pigeonpea yields, farmers' income, increased utilization/nutrition and improved livelihoods through (a) availability of improved germplasm that is high yielding and tolerant to fusarium wilt; (b) increased dissemination, up-scaling and adoption of the improved germplasm; (c) infrastructure and capacity building; and (d) increased linkages and partnerships. Four varieties belonging to long (ICEAP 00053, ICEAP 00932) and medium maturity (ICEAP 00554, ICEAP 00557) groups are in the pipeline for immediate release.

Agroecologies of pigeonpea cultivation in Tanzania

The total area under pigeonpea cultivation in 2011 was 264,090.26 ha (Fig. 2). Most of the pigeonpea is produced in the Southern, Northern and Central Zones which contribute about 80.06% of the total production (Fig. 2).

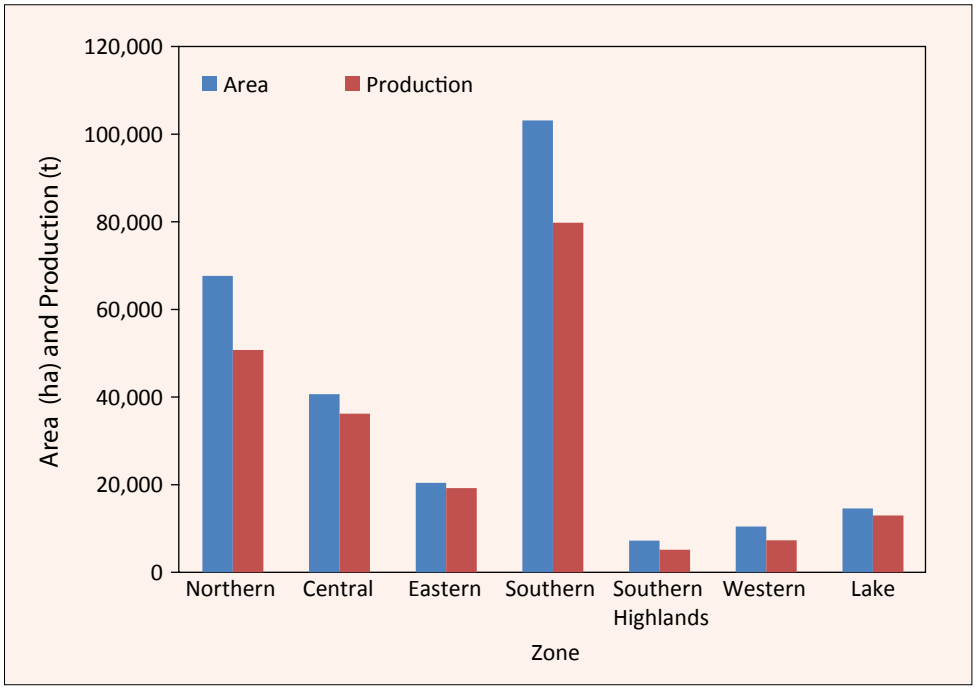

Figure 2. Pigeonpea area and production in different zones of Tanzania in 2011.

Seed systems

In Tanzania, seed production and marketing is largely by the informal sector (96%) with the formal sector accounting for about 4% (Source: Temu and Mtenga 2001). The informal seed systems include borrowing from neighbors/relatives, exchanging or purchasing stored food grains that are then used as seed by farmers. On the other hand, the formal seed system constitutes traders or stockists/agro-dealers selling certified seed. The ASA is the main seed organization mandated with the production of breeder, foundation and certified seeds for publicly developed crop varieties. The private seed companies mainly deal with hybrid maize and vegetable seeds where the market demand is high.

There is also the semi-formal seed production and supply system through the government's extension and research organizations that distribute seed to farmers in their course of conducting research (eg, on-farm trials and on-farm demonstrations). The informal and semi-formal seed production and distribution/marketing systems have been popular due to the deficiencies arising from the formal seed sector (eg, high price and non-production of seeds of legumes considered having low commercial potential by the formal sector).

Kilimo Sasakawa Global 2000 and ICRISAT initiated some collaborative efforts in the mid-1990s with extensionists, farmers' groups, TechnoServe, CRS, plantation estates, contract farmers and NGOs who started to produce quality pigeonpea seed and grain. Recently other partners like TL-II, private seed companies (Zenobia, Rotian Seed, Miombo estates, Krishna Seed Company, Kibodya Estate, Tanseed International), ASA and Soil Health Program under AGRA have facilitated availability of certified/quality and foundation pigeonpea seed.

Seed production targets

Total area: 264,090 ha

Seed rate (mean): 10 kg ha^{-1}

National seed demand: 2640 t (2012–14) to cover 264,090 ha

Capacity to deliver 20% of total area: 56,201 ha

Total seed required to cover targeted area of 56,201 ha ≃ 563 t

Opportunities, constraints, partnership and seed production plan

The opportunities, constraints, partnership and plan of the seed required to cover 20% area of each of the important pigeonpea growing areas are discussed.

Opportunities

- Farmers in the target and spillover areas have recognized that pigeonpea is a drought tolerant crop and most of the improved materials have tolerance to fusarium wilt coupled with early and synchronous maturity to catch up with the huge Indian market.
- The price offered by middlemen and traders for pigeonpea grain has been stable and relatively good over the years due to interventions from various partners like ICRISAT, TechnoServe, CRS and AGRA.
- There is available market and demand for the seed and grain within and outside the country.
- Right now there are more than 10 big companies/estates producing quality seed and grain for sale excluding community-based organizations (CBOs), NGOs, PMGs, farmers' groups and contract farmers. Hence all these sources should be able to contribute significantly to the seed plan.
- There is a conducive policy environment for seed production and the government is also in the process of granting exclusive rights to private seed companies as well as allowing them to produce foundation seed. This will certainly promote availability of seed to marginal areas where there was demand but unavailability as well as increased production of foundation seed are considered the major bottlenecks for certified seed production.
- The four genotypes in pipeline are expected to be released, as all of them have undergone on-farm testing and farmers' evaluation for a very long time and have been greatly accepted by farmers. This will contribute significantly to seed availability for all maturity periods.
- The country has also embarked on *Kilimo Kwanza* as Tanzania's Green Revolution to transform its agriculture into a modern and commercial sector. Some of its actionable pillars like political will to push agricultural transformation, enhanced financing for agriculture and incentives to stimulate investments in agriculture can support the seed plan.

Constraints

Several studies conducted in the country and especially in the Northern Zone indicated that the major constraints for pigeonpea production are:

- Diseases and field/storage pests
- Lack of high-yielding varieties
- Lack of formal markets coupled with grain traits preferred by farmers, and domestic, regional and international markets
- Seed systems that would support varietal diffusion
- Agronomic and pest management practices

Key partners

The key partners and their role are given in Table 2.

Seed production plan

Pigeonpea seed production plan for Tanzania is presented in Tables 3 and 4.

Table 2. Key partners and their roles in the pigeonpea seed strategy implementation.

Partner	Role
Research institutions (Ilonga, SARI, Naliendele, Uyole)	Germplasm development, variety release, produce breeder seed, dissemination
TOSCI – Tanzania Official Seed Certification Institute	Seed certification and quality control
ASA – Agricultural Seed Agency	Foundation and certified seed production, marketing
ICRISAT-TL-II	Funding, provide improved germplasm, capacity building, facilitate seed production and distribution, up-scaling
AGRA-Soil Health Program	Funding, facilitate seed production and distribution, up-scaling, capacity building
Extension services	Advisory services, farmers' mobilization and dissemination
Local government authorities/policy makers	Farmers' mobilization, supportive policy, funding, dissemination/up-scaling
NGOs, CBOs, Farmers' associations (MUVIMAHA, MUVIBAHA, UVIKI), Juhudi farmers' group, Kilimo market, African Farmers Service Centre	Mobilization of farmers, group formation, facilitate access to loans, inputs and markets, advisory services
Agro-dealers	Advisory services, inputs/seed availability, loans to farmers
Seed companies (Kibodya Farm, Tanseed International, Zenobia, Krishna, Miombo Farm, Southern Highland Seed Growers)	Seed production, marketing and distribution
Export Trading and Kamal Agro Ltd	Purchase of quality seed and grain, processing of grain
Contract farmers	Produce quality seed
Individual farmers	Seed buyers and users, grain producers and buyers, dissemination/up-scaling

Vision of success

Based on the estimate made from different sources, the pigeonpea area has increased during the last couple of years. This shows that there is a very big potential for the crop to grow and contribute to the GDP of the country bearing in mind that about 60–80% of the produce is sold outside the country especially to India. The climate change crisis and good prices offered have forced farmers to adopt pigeonpea in many parts of the country. The low rainfall received in many parts of the country leads to low cereal productivity especially of maize and wheat resulting in low income for the smallholders. Such low productivity and income makes farmers to shift to legumes production especially pigeonpea which is drought tolerant, and in most cases intercrop it with cereals mainly maize or sorghum. Furthermore, yields and income obtained from pigeonpea intercropped with maize in some pilot areas like Babati, Karatu, Kilosa, Kondoa, Arumeru, Hai and Moshi have improved smallholder farmers' livelihoods very much in several ways. Studies supported by the Soil Health Program under AGRA in the Northern, Central and Eastern Zones of the country have also shown that the yields of maize and pigeonpea can be increased twofold when farmers apply small amounts of P-based fertilizers like Minjingu fertilizers which are locally available at planting. The cost-benefit ratios obtained by such farmers were also about 2. Such high cost-benefit ratios have attracted farmers to adopt the practice and thus further improve their livelihoods.

Recently farmers have started selling green pigeonpea in the local markets, while a number of agro-dealers are selling quality seed to farmers. Also, some local restaurants are serving green pigeonpea along with or instead of green pea. These are new avenues which can increase demand and success of the crop.

Table 3. Pigeonpea seed roadmap for Tanzania.

Ecology (Zone)	Demand (ha)	Promising varieties	On-farm yield potential (t ha^{-1})	Seed rate (kg ha^{-1})	Area to be covered		Breeder seed 2012		Foundation seed 2013		Certified seed 2014		Seed to reach 20% adoption (t)
					Total (ha)	Per variety (ha)	Area (m^2)	Production (kg)	Area (ha)	Production (t)	Area (ha)	Production (t)	
Northern	67,650	4			16,913		200	20	2	2	170	170	170
	33,825	Mali	1	10		6,765	80	8	0.8	0.8	68	68	68
	16,915	ICEAP 00053	1	10		3,383	40	4	0.4	0.4	34	34	34
	16,915	ICEAP 00554	1	10		3,383	40	4	0.4	0.4	34	34	34
	16,915	ICEAP 00557	1	10		3,383	40	4	0.4	0.4	34	34	34
Central	40,670	3			8,134		90	9	0.9	0.9	81	81	81
	20,335	Mali	1	10		4,067	50	5	0.5	0.5	41	41	41
	10,170	ICEAP 00053	1	10		2,034	20	2	0.2	0.2	20	20	20
	10,170	ICEAP 00554	1	10		2,034	20	2	0.2	0.2	20	20	20
Eastern	20,410	3			4,082		40	4	0.4	0.4	40	40	40
	10,205	Mali	1	10		2,041	20	2	0.2	0.2	20	20	20
	5,105	Tumia	1	10		1,021	10	1	0.1	0.1	10	10	10
	5,105	Komboa	1	10		1,021	10	1	0.1	0.1	10	10	10
Southern	103,120	4			20,624		240	24	2.4	2.4	208	208	208
	25,780	Mali	1	10		5,156	60	6	0.6	0.6	52	52	52
	25,780	Tumia	1	10		5,156	60	6	0.6	0.6	52	52	52
	25,780	ICEAP 00554	1	10		5,156	60	6	0.6	0.6	52	52	52
	25,780	Komboa	1	10		5,156	60	6	0.6	0.6	52	52	52
Southern Highlands	7,220	3			1,444		20	2	0.2	0.2	15	15	15
	3,610	Mali	1	10		722	10	1	0.1	0.1	7	7	7
	1,805	Tumia	1	10		361	5	0.5	0.05	0.05	4	4	4
	1,805	ICEAP 00554	1	10		361	5	0.5	0.05	0.05	4	4	4
Lake	14,590	3			2,918		40	4	0.4	0.4	29	29	29
	7,295	Mali	1	10		1,459	20	2	0.2	0.2	15	15	15
	3,650	Tumia	1	10		730	10	1	0.1	0.1	7	7	7
	3,650	ICEAP 00554	1	10		730	10	1	0.1	0.1	7	7	7
Western	10,430	3			2,086		30	3	0.3	0.3	20	20	20
	5,215	Mali	1	10		1,043	10	1	0.1	0.1	10	10	10
	2,610	Tumia	1	10		522	10	1	0.1	0.1	5	5	5
	2,610	ICEAP 00554	1	10		522	10	1	0.1	0.1	5	5	5
Total	264,090				56,201	56,201	660	66	6.6	6.6	563	563	563

Table 4. Certified seed production (t) plan over three years.

Variety	2012	2013	2014
Mali	31	54	128
ICEAP 00053	8	14	32
ICEAP 00554	18.5	31	72.5
ICEAP 00557	5	9	20
Tumia	11.5	20	46.5
Komboa	9	16	37
Total	83	144	336