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Household, Small and Medium Scale Processing of Soya Bean (*Glycine max*) in Tanzania

Richard Trevor Wilson*

Bartridge House, Umberleigh, UK

***Corresponding author:** Richard Trevor Wilson, Bartridge House, Umberleigh, UK. Tel: +441769560244; Email: trevorbart@aol.com

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Abstract

Soya beans are a minor crop in Tanzania. Production is mostly by smallholder farmers using traditional cultivation methods. A small number of larger scale enterprises also grow soya. Soya is processed in Tanzania for human food and for livestock feed. The emphasis in human food is to improve the nutritional and health status of Tanzania's people by fortifying traditional cereal staples with soya. Processing for human food is mostly carried out by small and medium enterprises who source their soya beans from within the country. Soya is being increasingly used in livestock feeds as a protein replacement for the dried fish which has been the usual source of protein in the past. Processing for livestock feed includes some large-scale operators who mainly use imported soya bean meal in their products. The Tanzania Government has very ambitious plans for development of soya beans for both people and animals but has made little progress towards its target as set out in the Soya Bean Development Strategy 2010-20102. There is, however, a bright future for soya in Tanzania.

Keywords: Development Strategy; Fortified Foods; Health; Livestock Feed; Nutrition; Small and Medium Enterprises

Introduction

Soya beans *(Glycine max* L.) have been grown in Tanzania since as early as 1912 when the country was the German East Africa Colony [1]. There was then little interest in the crop until the late 1950s/early 1960s when the country then known as Tanganyika was a United Nations Trust Territory administered by the United Kingdom. This interest arose after the lack of success by the Groundnut Scheme (Overseas Food Corporation) [2] when it was considered that soya bean would be a better crop to grow [3,4]. Since independence in 1961 and the union with Zanzibar in 1964 to become the United Republic of Tanzania there has been mainly sporadic interest in the crop and few financial, human or technical resources were devoted to it [5]. There have been, nonetheless, some breeding experiments and imports of soya genetic resources over the years [6]. At the beginning of the second decade of the 21st Century one research station in the Southern Highlands Region had a small experimental programme on soya and a few large-scale farmers were carrying out their own variety trials (Figure 1).

Figure 1: Soya bean variety testing on a private farm in the Southern Highlands of Tanzania.

Soya bean is, and always has been, a minor crop in Tanzania. It contributes, nonetheless, to national and household food supply, provides income, adds diversity to arable production systems and (as it is a legume) fixes nitrogen that improves soil fertility and condition. Much of Tanzania is suitable for cultivation of the soya bean and it is indeed grown in most areas. Most soya is grown by smallholder farmers under rainfed conditions in small plots using local or "Nondescript" varieties that are produced from home saved seed and using traditional husbandry methods. Some larger mechanized farms in the Southern Highlands already grow, or have well advanced plans to grow, soya bean: these are or will be partially integrated operations with some degree of processing and organized marketing. Annual production of grain soya in the early twenty-first century has been in the range of 3000-5000 tonnes from a cultivated area of 5000-6000 ha [7]. Production is effectively entirely for the domestic market, but the supply is considerably less than the demand. There are formal imports, mainly from India and neighbouring countries to overcome the deficit and there are also some "Informal" imports from Tanzania's contiguous states. Soya and soya lecithin, as indicated on the small print of the ingredients list on the product packaging, is found in a vast array of food products, especially those imported from the USA, but most consumers are unaware of this. Soya "Milk" is imported from various parts of the globe (Figure 2).

Figure 2: Soya drinks and soya milk (outer -- British company but made in Germany, inner -- British company made in Britain [soya grown in Europe], middle - Malaysian company.

National production of soya beans was estimated at 776 tonnes in 1975. Soya bean output in 2007 was 4000 tonnes from 11 000 ha or an average yield of only 364 kg/ha and 4000 tonnes of soya or its products were imported in that year. Estimates of recent production in five regions, provided by the regional or district agricultural officers, indicate that these alone are responsible for about 51 per cent of national soya bean output, that the area potentially available for soya bean (based on areas where maize is cultivated) is a minimum of 630 000 ha and the potential production in these areas is 1.07 million tonnes. The Ministry of Agriculture, Food Security and Cooperatives (MAFC) has established targets for the growth of soya bean production starting from a base of 3500 ha under cultivation in 2010 and an output of 5000 tonnes of beans to a cultivated area of 1.4 million ha in 2020 and an output of 2.0 million tonnes [8].[1]

Many small and medium enterprises, mostly based in Dar es Salaam or Arusha but also in other cities around the country, produce various human and animal foods that make use of soya. Processors of fortified human foods and animal feeds, however, face problems of supply of their basic material - the whole soya bean - due to erratic supply and inconsistent quality.

Note: [1]These targets are clearly beyond the bounds of possibility. The 2010 "Data" assume a grain yield of 1.43 tonnes/ha, greatly in excess (possibly 3-fold) of what is actually achieved in the country and there is no indication on the ground that the cultivated area and crop output is anywhere near the 10-fold increase targeted from 2010 to 2013 although actual output in the latter year may approach 5000 tonnes. The targets for seed imply that only a small proportion of the projected area will be planted with seeds not saved by the farmers themselves.

Methodology

This paper is extracted from a detailed study of soya bean production, processing and marketing in Tanzania [9]. The information on processing which follows was principally obtained through one-on-one interviews with owners, managers and staff of the processing enterprises.

Processing

Overview

The soya bean is an excellent source of oil and protein [11-13]. The International Institute of Tropical Agriculture (IITA), with headquarters in Ibadan in Nigeria, introduced the soya bean to its food crops research programme in the late 1970s [10]. By that time, however, much was already known about its properties and uses. The bean is a rich source of edible oil that does not contain cholesterol and has very low levels of saturated fats. Oil is extracted for human consumption and industrial uses. Soya bean meal, whether full fat or defatted, accounts for nearly 80 per cent of the physical output. Soya oil is an ideal food for people with cardiac problems and for those who wish to avoid heart disease. It has a high level of lecithin - an important constituent of all organs of the human body and especially of the nervous tissue, the heart and liver -- and is a good source of several fat-soluble vitamins. Soya bean meal is considered the most valuable end product of processing and is converted to various protein rich foods and feed products. A major food product of soya is tofu - popular in many East and Southeast Asian countries and beloved of vegetarians and vegans everywhere -- also called bean curd -- made by coagulating soya milk and pressing the curds into soft white blocks [14].

Tofu is low in calories, has a relatively high protein content, contains little fat and is high in iron [15,16]. Soya is used in industry in the manufacture of margarine, vegetable ghee, milk, and pastries and is found in paints, varnishes, adhesives and clothing. Soya protein concentrate, protein isolate and textured protein are constituents of many commercial foods. The functional properties of soya protein have given rise to many new products and improved the quality of existing ones. There is also the possibility of using esterified soya bean oils for the production of biofuels. Soya in one form or another is a major component of many animal feeds [17,18]. Soya beans are a highly versatile crop with innumerable prospects for support of many agroindustries.Processing, for practical purposes, can be considered to start from the moment soya bean leaves its point of production, either sold by the owner to an agent or stored by him/her personally on the journey to market. From this point there is a multiplicity of variations in the pathways a bean follows before it ends up as human food, livestock feed or for industrial applications (Figure 3).

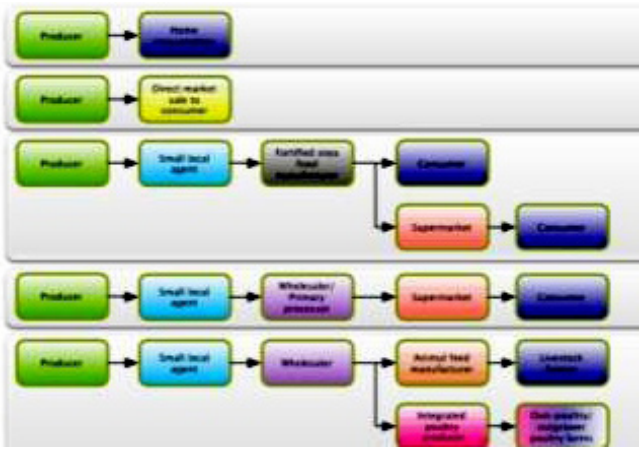

Figure 3: Representative examples of pathways followed from point of production to final use for soya bean and its products.

Home Use

Soya is sometimes considered a difficult crop for smallholder producers because it requires some form of processing before it can be used. Although home processing is rather simple it involves several steps and, for example in the case of making soya milk (Figure 4), can be very time consuming. A project that was directed mainly at women and primarily designed to help them with home processing was started in the Njombe area in the 1980s but, as with many such initiatives, faded away with the cessation of project funding. In an indirect line of descent, the current 'Soya ni Pesa' (soy is money) project financed by the United States Department of Agriculture (USDA) through Catholic Relief Services (CRS) continues this work [19]. There is increasing consumption and availability of prepacked products containing soya, partly as a result of Government publicity and encouragement via the written, oral and visual media. It can be expected that there will be greater use of technology to increase home processing and consumption of soya in the future.

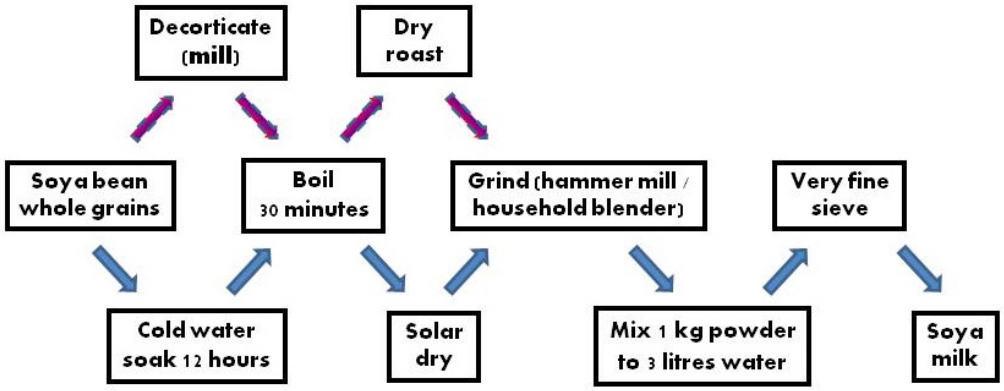

Figure 4: Steps involved in home processing of raw soya beans to soya milk.

Fortified Foods and Other Speciality Products for Human Use

There are multiple possibilities for soya beans to contribute to human nutrition, all the way from the cradle to the grave. In the 1970s the Tanzania Government in collaboration with the United Nations Children's Fund (UNICEF) set up a pilot project in several villages to produce full fat soya flour. At about the same time, from experiments undertaken in the country, it was considered that soya beans, with a higher lysine content than groundnuts, were a potential source of protein supplement to cereal diets. Perhaps consequent on this, soya flour began to be used in porridge at a ratio of 1:3 with maize flour. Bread made with 10 per cent soya and 90 per cent wheat flour was then common especially in Morogoro Region and porridge and soya milk were used extensively in school feeding programmes and were highly appreciated. There seems to have been little long term benefit from and continued use of any of these initiatives.

New demands for soya products are, however, arising. These demands, for example, are for people who are immuno-compromised (HIV/AIDS), for those who need special diets to replace cow milk (lactose intolerance) and for speciality items for the aged and infirm. In contrast to the perceived wisdom regarding the benefits of soya as a food fortifier there is an emerging controversy on the human health risks associated with over consumption of soy products in respect of hormones and the perceived economic threats associated with their dissemination into developing countries [20]. The options vary from area to area and consumer group to consumer group. In Tanzania locally processed products already on the market include baby food, soy milk powder, pure soy flour, a "Power" flour known as 'lishe' with soya milk, rice and maize and other cereal flours, other fortified flours of wheat and maize for staple foods such as 'ugali' and 'uji' and for confectionary products (bread, buns, chapatti, cake and biscuits), a drink similar to coffee and the beans after heat extrusion mixed with cereal grains (Figure 5).

Figure 5: A range of soya products produced in various cities in Tanzania.

In addition to local produce, the ubiquitous soy sauce, soya bean oil, soya lecithin and yet more soya in one form or another is present in an amazing range of other imported products such as creamy wheat cereal, mayonnaise, Worcestershire sauce, organic and non-organic soya drinks, soya milk cappuccino, soya milk itself fortified (with collagen, vitamins, iron and calcium), family porridge, margarine, infant foods from starter via follow-on through to 1- to 3-year olds, and even peanut butter! These products derive from (usually non-genetically modified, non-GM) soya beans grown in various parts of the world ranging through North and South America, Europe and Asia and manufactured in a bewilderingly diverse array of countries in Africa itself, North America, Europe, the Middle East and East and Southeast Asia. Not all, and possibly none, of the identified Tanzania products are fully exploited. The supply of raw beans in terms of both quantity and quality is problematic as is the purchase of machinery (either mechanical expellers or solvent extractors) suitable to Tanzania conditions.

Cultural and culinary barriers arise from the preference of people who prefer to eat food that they know. In spite of this there is a burgeoning food fortifying industry comprising a considerable number of small to very small operators - many of whom have received training through the Small Industries Development Organization (SIDO) [21] - and a smaller number of medium to large scale processors supplying current demand and creating opportunities for the future. Most processing is based in Dar es Salaam or Arusha although nascent specialist businesses are developing in other parts of the country. Some small operations are not registered for barcodes, yet barcode technology is gradually bringing about a business revolution particularly to SMEs in other sectors. Barcodes are fundamental in promoting the competitiveness of local manufactured goods in both national and international markets and enable the tracing of products. The use of barcodes compels manufacturers to adhere to the quality standards that are now considered a necessary component in the competitive market and there is a direct relationship between use of bar codes and the quality of products. Barcode technology has greatly contributed to increased sales of local products in supermarkets and other retail outlets. In the 18 months following their introduction in Tanzania more than 360 companies adopted the technology for almost 6000 varieties of goods.

Case Study 1: Small is beautiful - an Arusha home-based initiative supplying foods fortified with soya: Esther Daniel Nassary is a micro scale processor with macro size ambitions who was helped to set up her business by initial and continuing training by SIDO. Joshua Products (named for her son born after an unusually long period of four years into her marriage) was set up in 2011. Although still in the process of registration by the Tanzania Food and Drugs Authority (TFDA) and the Tanzania Bureau of Standards (TBS) things are happening. Esther uses an agent in Babati opening parenthesis north central Tanzania) to buy soya from local producers - who may sell lots of only 20-30 kg - and has it delivered to the garage under her house that is her "Factory". Rather than go through the long and slow progress of processing towards milk (Figure 4) she decorticates her soya to remove the outer coating in a local hammer mill. Her range of products includes fortified flour, soya drink powder and a soya mix and soya meal with which customers can mix their own fortified foods (Figure 6). Her main product is fortified flour (a mixture of maize, wheat, finger millet, sorghum, rice, millet and 10 per cent soya, mixed manually) which she sells wholesale to an agent. The inner plastic liming is sealed by hand by passing it across a candle flame. The outer cardboard packaging is produced and printed in Nairobi as are the containers for three other products sold in plastic bottles of 200 g. Her turnover, including about 300 kg of soya, is over 3 tonnes per month, to produce which she employs 6 women and 4 men. Esther retails some of her own product direct in Arusha or travelling by local bus to Moshi and Babati. She also sells wholesale to agents who resell in Mwanza, Shinyanga, Babati and Tanga.

Figure 6: Small scale processing of soya into value-added product in Arusha (The proud entrepreneur, hand sealing of product bags, a sample of the wares, fortified flour).

Case Study 2: Is bigger better? - a Dar es Salaam medium scale enterprise producing soya foods: Power Foods Industries Ltd was established in 1993. From very small beginnings it has become a company to contend with in the manufacture of fortified foods. Some 28 people are employed in the Dar es Salaam factory and six ladies travel the country by bus promoting and selling the company's products. Anna Moshi, the Managing Director of Power Foods, was born in the Kilimanjaro Region and was among the first to graduate in 1984 in the then unfashionable discipline of Food Processing. She worked in the banking sector for 9 years until she had enough money to set up her business. Her vision for the company is for it to become a leader in the processing and distribution of high quality nutritious and safe food as a contribution to the fight against malnutrition among children and other vulnerable groups in Tanzania and across the world by 2025.

In order to help her achieve this vision she has undergone further training in food and especially fortified food production by SIDO in Tanzania and through two short courses in the USA. In 2000 Anna bought a mechanical expeller in the United Kingdom that was suitable for the treatment of soya beans. She now produces a range of products with soya as an ingredient (Figure 7). Beans are obtained from Zambia and from contract farmers in the Morogoro and Songea areas of Tanzania. Anna works in collaboration with IITA and the Association for the Strengthening of Agricultural Research in Eastern and Central Africa (ASARECA) to train farmers to produce soya. The factory is capable of processing up to 300 tonnes per year of soya (up to 3000 tonnes total output). The World Food Programme and Save the Children were major customers in the past but are so no longer. The company sells products direct to public and private sector orphanages and to supermarkets and larger shops around the country. The two retail outlets owned directly by the company are also a major source of sales.

Figure 7: A medium scale enterprise producing a range of soya-fortified foods.

Animal Feed

The main potential demand for soya bean products will be the animal feed industry. In the world as a whole only 2.5 per cent of soya meal is used for human food and in industries other than animal feed. Dairy and beef cattle consume 21 per cent of the word's soya meal, pigs 25 per cent and poultry 46 per cent [22]. The combination of price and nutrient characteristics favour soya meal for pigs and especially poultry. Soya meal is highly digestible and is high in the amino acids that complement those in cereal grains.

There is already limited use of soya cake or meal by some larger feed manufacturers in Tanzania. It is hoped that soya cake or meal will replace, totally or partially, the ground 'dagaa' (sun-dried small fish) which is currently the common protein source in locally manufactured feeds. Local users and potential users of meal are concerned about supply possibilities from internal sources and have already imported or intend to import meal. Imports have been mainly from India, either of solvent-extracted ("De-Fatted", crude protein content 44.0 per cent, ether extract 0.5 per cent) or full fat meal (crude protein 38.0 per cent, ether extract 18.0 per cent). Solvent meal has a slightly higher digestibility percentage than de-fatted for ruminants but de-fatted meal has 5 per cent greater metabolizable energy content for poultry - which are the main species using soya meal in Tanzania - than solvent-extracted. Both meals are similar in the composition of essential amino acids but de-fatted meal has higher (sometimes much higher) vitamin contents. Mineral contents are low but similar for macrominerals in both meals whereas microminerals (iron, copper and zinc) tend to be lower in full than in de-fatted meal.

One new buyer of soya beans for poultry feed in the Southern Highlands estimates a requirement of 1000 tonnes per month for processing over a 10-year time horizon. In Dar es Salaam two of the main (potential) users estimate requirements of 650 tonnes per month and 300 tonnes per month in the very near future. A feed manufacturing company in Morogoro that buys soya locally produces soya oil and uses the expeller cake in its own mixed poultry feeds (Figure 8). It estimated a requirement of 200 tonnes in 2013 with higher needs in the longer term. Use of an expeller as opposed to solvent extraction also has the advantage that the heat generated in the process denaturises enzymes such as urease and trypsin inhibitors that would otherwise reduce the nutritional value of the meal thus avoiding the necessity of having to toast the meal as a separate operation.

Figure 8: Soya oil and expeller cake processed in Morogoro from local whole soya beans.

Case Study 3: Let Them Eat Cake - Supplements and Concentrate Feed Manufacture for Livestock: There is strong and growing demand for concentrate feeds and supplements from the white meat chain and for table egg production. Poultry feed comprises a range of products including chick starter, chick special starter (with a coccidiostat included), layers mash, broiler starter, broiler grower and broiler finisher, each of different formulation sold at a different price (Figure 9). Several industrial scale millers produce livestock feed, in part to add value to the maize bran that is a by-product of milling. Many large, medium and small-scale manufacturers plus many village millers produce feed as do "Home Mixers". Some large millers have automated (computer-controlled mix proportions) 20-tonne batch mixers capable of producing pellets as well as meal. The main ingredient in stock feed is maize bran (about 70 per cent of the mix) followed by sunflower

cake, fish meal (powdered 'dagaa'), locally grown whole (ground) soya beans (although imported de-fatted Indian meal is preferred as it is of assured quality and cheaper than the local product and is to a great extent replacing fish meal in rations), meat and bone meal, salt, lime and super lick.

Figure 9: Soya in animal feeds.

Legal requirements for declaration of ingredients and proximate composition of the mix are in place for display on packaging but are not enforced. The larger firms usually have analyses done by commercial laboratories, TBS, Tanzania Industrial Research Development Organization (TIRDO) or Sokoine University of Agriculture (SUA). There is interest in increasing the social contribution of feed firms. International Tan Feeds Ltd is a share holding company based in Morogoro whose main activities are purchase of cereals and cereal by-products and other ingredients from farmers for processing as animal feed. The company aims to develop a value chain starting with small crop farmers, through rural and urban livestock keepers and finally to consumers of livestock products. Tanfeeds' mission is to produce high quality feeds in order to promote efficient livestock production. It envisages adding value to crops and byproducts via high quality animal feed. Maximizing local feed resources is key to providing a sustainable market for small farmers. The vision is to become a leading animal feed producer based on efficient use of local resources. Management staff include specialists in animal production, nutrition and health.[2]

Discussion and Conclusions

The processing of soya beans is beset with problems, some cascading down from "Above" (laws, regulations, unwarranted and unproductive interference), some seeping up from "Below" (lack of organization, poor facilities, non-discriminating customer base). The main issues around processing are:

- A disorganized and largely incomplete market chain;
- Lack of competition amongst buyers (farm gate prices are similar throughout the country, but sellers seem generally to accept these without much complaint);
- Complicated and conflicting regulations that are not usually enforced;
- Untrained and unskilled farmers and processors;
- Lack of or inadequate equipment and tools from initial producer to processor and beyond;
- Little interest on the part of many domestic customers in products of better quality or with value added attributes; and
- A limited (but expanding) range of products lacking both quality and quantity.

The soya bean processing community is small but is vibrant and dynamic. Fortification of staples in the human diet is a worthy activity and is mostly carried out by small and medium scale entrepreneurs. This community should receive training in and assistance for the development of harmonized fortification and food safety standards and quality control for internal and cross border issues for manufacturing and supply chains for Ready to Use Therapeutic Foods (RUTF). Such assistance should be in the form of development finance and additional training, possibly through an expansion of SIDO activities. Activities in animal feed production are also carried out by small and medium enterprises but there are also some large-scale operations. This subsector needs less support and is largely capable of making its own way. Processing of soya for both human food and animal feed can be expected to become more important in Tanzania and will grow and expand in the future.

Note: [2]Tanfeeds was successful in obtaining large amounts of grant and loan funding from two international sources.

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