BACKGROUND PAPER

Oilseeds and Cowpeas

Prepared by:

Nteranya Sanginga IITA

David Bergvinson, ICRISAT

EXECUTIVE SUMMARY

Oil seeds (soybean, shea butter and groundnuts) and legumes (cowpeas) are important crops in sub-Saharan Africa (SSA) as they provide a range of economic, social, and environmental benefits. For example, these crops are cheaper sources of proteins and are often cultivated by women for household consumption and income generation. Soybean is grown by approximately one million farmers and has considerable potential for arresting declining soil fertility, enhancing household food and nutrition security, and raising rural incomes. The dramatic increase in world soybean prices has influenced domestic prices in SSA, making it more rewarding for farmers relative to other food or cash crops. Groundnuts are ranked fifth among oil seed crops in the world after oil palm, soybean, rapeseed, and sunflower; i is an important oil, food, and feed legume crop grown in over 100 countries covering 25.44 million ha with a total production of 45.22 million tons of pods in 2013. Sub-Saharan Africa accounts for about 95% of global productionof cowpeas, with over 80% of Africa's share produced in West Africa. With an estimated 50% share of the global cowpea production, Nigeria is the world's largest producer (and consumer) of cowpeas, followed by Niger and Burkina Faso.

Despite past research and development investments in oil seed and legume crops to improve their productivity, competitiveness, and profitability, many challenges remain. These include a range of abiotic stresses (notably land degradation and drought), biological threats (insect, dieseases, and weeds), input and ouput market failure, lack of appropriate production and postharvest technologies, policy constraints, poor technology delivery systems, and consequently low adoption of improved technologies. R4D programs in SSA have successfully demonstrated, in many countries, activities that increase grain yields, control destructive pests and diseases, minimize the effects of drought, and connect producers with markets, albeit on a pilot scale. These successes need to be scaled-out to benefit more poor farmers, processors, traders, and consumers. A consortium of partners has designed a strategy to collectively tackle these challenges, by building upon available opportunities in SSA such as availablity of national and regional consumer markets, processing industries, a range of yield-enhancing technologies, and better policy instruments to better commercialze these commodities.

To achieve improvements in the productivity and commercialization of these crops, the strategy proposes four strategic interventions: (1) facilitate efficient legume seed delivery systems for smallholder farmers; (2) validate and promote technologies that improve the productivity, competitiveness, and profitability of oil seeds and legumes; (3) expand postharvest processing and market opportunities; and (4) improve related capacities and infrastructure to enhance knowledge sharing. Activities under these strategies will be undertaken in an integrated manner. For example, yield-enhancing technologies will be combined with improved postharvest value-adding and labor-saving technologies to optimize productivity. Better approaches will be developped to link producers to input and output markets. Implementers will develop innovative tools and approaches to strengthen the skills of stakeholders. We will work in multidisciplinary teams and with multiple partners through innovation systems approaches. Knowledge generated by these interventions will be shared using various approaches and linkages with partners. These interventions will be implemented in at least 20

countries selected based on comparative advantage. The expected benefits include increased crop productivity and value addition that will create job and income opportunities for rural communities, and reduced poverty levels in SSA.

1. BACKGROUND

1.1 SOYBEAN

Soybean is an important crop for at least one million smallholder farmers in Africa. It has considerable potential for arresting soil and declining fertility, enhancing household food and nutrition security, and raising rural incomes thus reducing poverty. The dramatic increase in world soybean prices has influenced domestic prices in Africa. As a result, the production of soybean has become more rewarding to farmers compared to other food or cash crops. A number of other factors have generated growing demands for soybeans, such as for domestic processing to meet the rising domestic demand for soybean meal primarily to supply the poultry feed industry, and the positive prospects for edible oil. Despite the growing demand, SSA produced only about 2 million tons of soybeans in 2011-2013 (Table 1). The United States, Brazil, and Argentina alone account for over 75% of the world soybean production of about 260 million tons in 2011-2013. Global soybean production and trade is characterized by a high level of concentration and specialization, implying that smallholder producers in Africa can hardly compete on world markets. As the three leading soybean exporters, the United States, Brazil, and Argentina will continue to account for nearly 90 percent of the world's aggregate exports of soybeans, soybean meal, and soybean oil during the coming decade.

	Production (tons)	Area (ha)	Yields (tons/ha)
World	**259,829,434**	**106,664,475**	**2.45**
United States	85,243,243	30,452,647	2.80
Brazil	74,121,364	25,602,945	2.90
Argentina	46,095,056	18,580,791	2.48
Others	54,369,771	32,028,092	1.70
Sub-Saharan Africa	**2,039,720**	**1,680,740**	**1.21**
South Africa	715,000	469,000	1.52
Nigeria	580,951	622,550	0.93
Uganda	196,100	159,667	1.23
Zambia	193,547	89,885	2.15
Malawi	98,078	97,458	1.01
Zimbabwe	86,667	58,667	1.48
Ethiopia	49,548	26,233	1.89
Rwanda	26,936	38,796	0.69
Burkina Faso	23,045	21,432	1.08
DR Congo	21,326	41,333	0.52
Benin	14,667	18,333	0.80
Cameroon	13,020	11,656	1.12
Tanzania	4,651	4,670	1.00
Gabon	3,700	4,233	0.87
Kenya	3,400	1,865	1.82
Liberia	3,200	7,483	0.43
Burundi	2,963	3,609	0.82
Mali	1,917	2,850	0.67
Cote d'Ivoire	962	945	1.02
Madagascar	44	75	0.58

Table 1: *Soybean production, area, and yields in SSA, 2011-2013. Source: FAOSTAT (www.faostat.org).*

Over the 1990-2013 period, soybean production in SSA grew at an average rate of 6.5% per year (Figure 1). With annual growth rates of 3% in area and 3.5% in yield, both area expansion and yield growth have made roughly comparable contribution to the observed growth in soybean production in SSA. Average yields increased from less than 1 ton/ha before 2000 to about 1.2 tons/ha in 2011-13. Despite these positive trends, the average soybean yield in SSA (1.2 tons/ha) is much lower than the global average yield of nearly 2.5 tons/ha. The low yields are due to a number of production constraints and low adoption of improved varieties and agronomic practices.

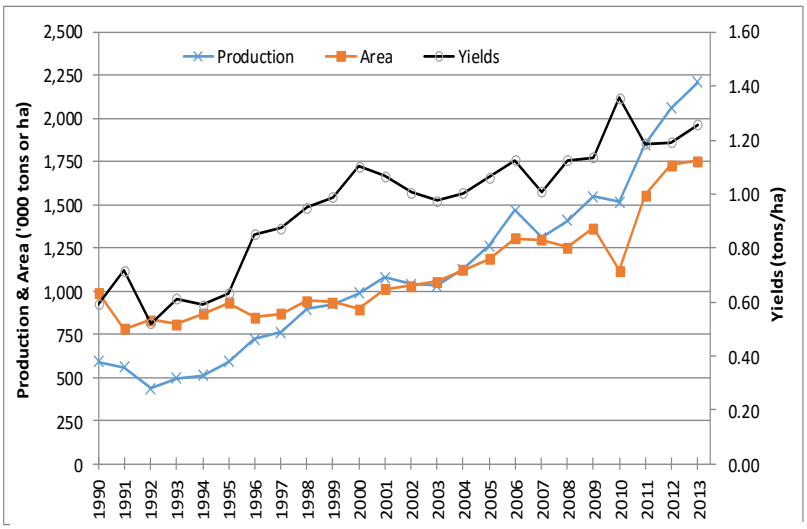

Figure 1. *Trends in soybean production, area, and yields in sub-Saharan Africa, 1990-2013. Source: FAOSTAT (www.faostat.org).*

The International Institute of Tropical Agriculture's (IITA) experience with soybean in Nigeria has demonstrated the possibility of increasing soybean production and productivity through a value chain approach to technology development and dissemination. The IITA developed and disseminated improved varieties as well as household-level soybean processing technologies coupled with product development aimed at promoting technology adoption. Currently, over 80 soybean-based agro-processing businesses exist in Nigeria. As women also handle much of the soybean production, they can easily integrate production, processing, and marketing activities to generate cash incomes in addition to ensuring household food and nutrition security through increased home consumption (Sanginga et al, 2003). Promotion of soybean recipes in Nigeria led to increased local trading of soybean food products, with attendant improvement in the nutritional status of many Nigerians, particularly infants and school children. Increased demand for soybean-derived products in turn led to increased production of soybeans (World Bank, 2009). Poor households in Nigeria account for the production of over 80% of soybean, implying that soybean is produced predominantly by the poor who thus stand to benefit from soybean research and extension (Alene et al, 2009). Akinola et al. (2009) measured the economic impacts of soybean-maize rotation research involving promiscuous soybean varieties in Nigeria, Ghana, Togo, and Benin and the results showed that soybean-maize rotation research and extension generates a rate of return in the range of 35% to 43%. Alene et al. (2009) assessed the overall economic gains as well as the equity effects of alternative commodity research programs in Nigeria and found that, with a rate of return of 72%, each dollar invested in soybean research generates US$46 worth of benefits for the poor, relative to $70 for all households. Poor households in Nigeria thus capture 66% of the benefits from soybean research.

If past trends in soybean area expansion and yields continue into the future, Africa is projected to have a deficit of over 1.5 million tons by 2030. The projections show that Africa will be one of the main sources of growth in world soybean demand and this represents a significant opportunity for Africa to realize considerable foreign exchange savings through increased domestic production for import substitution. However, the growing domestic demand for soybean is unlikely to be satisfied through domestic production without major research and development investments aimed at raising the productivity, profitability, and competitiveness of smallholder soybean production. Such investments are justified because, while the bulk of soybean production in other regions comes from large-scale commercial farms that are characterized by capital intensive production methods and a high level of mechanization, smallholder farming using labor intensive cultivation methods accounts for the largest share of soybean production in Africa. In Africa, the contribution of soybean to the food security of rural households tends to be relatively more significant than elsewhere.

1.2 GROUNDNUTS

Groundnut is ranked 5th among oilseed crops in the world after oil palm, soybean, rapeseed, and sunflower. Groundnut is an important oil, food, and feed legume crop grown in over 100 countries, covering 25.44 million ha worldwide with a total production of 45.22 million tons of pods in 2013 (FAOStat, 2014). Asia and Africa are the main groundnut-producing continents, accounting for over 90% of global groundnut production. Of the top 20 groundnut- producing countries, 12 are from Africa (FAOStat, 2014). Africa accounts for 40% of groundnut area but contributes only about 26% of world production owing to low productivity. In Africa, groundnut is both a cash and a food crop cultivated on marginal lands under rain-fed conditions with low inputs by resource-poor farmers. It is an important cash crop for many households, accounting for up to 50% of rural cash earnings, and a major source of employment. Although Africa's share in the global groundnut market has declined, the crop also accounts for a significant share of export earnings in some countries (for example, 8% in Senegal and over 84% in Gambia in 2002).

Groundnut is a nutritious food and contributes to improved health of the rural population. It is rich in protein, oil and several micronutrients and hence is important for combating protein, energy, and micronutrient malnutrition. In countries where malnutrition is a major problem, groundnut-based ready-to-use therapeutic food products like "Plumpy nut", peanut butter have helped save the lives of thousands of malnourished children (UNICEF, 2007). The amino acid profiles of groundnut complement that of cereals, such that consuming them together raises the nutritional effectiveness of both. Reports from Ghana indicate that vitamin A and iron deficiencies are extremely widespread and are associated with negative health outcomes (Anim-Somuah et al, 2013). Pregnant and breastfeeding women and children under two years are in general the most vulnerable groups. Groundnut was identified as an important crop with a potential to contribute to nutrient-dense foods in Ghana. Groundnut products scored highly on five important conditions (nutritional quality, affordability, acceptability, integrity and signaling, and business interest) necessary for foods to contribute to reducing under-nutrition (Anim-Somuah et al., 2013). The food products meet the key criteria of availability, affordability, acceptability and nutritional quality.

The groundnut haulms, which contain 8-15% protein, 1-3% lipids, 9-17% minerals, and 38-45% carbohydrates, are used as cattle feed either in fresh or dried state or for preparing hay or silage. The digestibility of nutrients in groundnut haulm is around 53% and that of crude protein 88% when fed to cattle. Haulms release energy up to 2.337 cal kg^{-1} of dry matter (Singh and Diwakar, 1993). At the peak of the dry season, the cost per weight of haulm can be equal to that of the grains. The oilcake meal remaining after oil extraction is used as industrial raw material and also as a protein supplement in livestock feed rations. Being a legume crop, it helps to fix atmospheric nitrogen in soil and therefore is an important component in crop rotation or mixed cropping systems.

1.3 COWPEA

Globally, an estimated 6.4 million tons of cowpea is produced annually on about 12.7 million hectares (Table 2). Sub-Saharan Africa (SSA) accounts for about 95% of global cowpea production, with over 80% of Africa's share produced in West Africa. With an estimated 50% share of the global cowpea production, Nigeria is the world's largest producer (and consumer) of cowpea, followed by Niger and Burkina Faso. Globally, the share of cowpea in total area under pulses grew from less than 10% in 1990 to nearly 25% in 2012. In West Africa, cowpea occupies over 85% of the area under pulses and 10% of total cultivated land (Alene et al, 2012). Poor households in Nigeria account for the production of over 65% of cowpea, implying that cowpea is produced mainly by the poor who thus stand to benefit from cowpea research and extension (Alene et al, 2009). Cowpea offers multiple benefits to smallholder farmers in terms of food, cash income, livestock feed, and improved soil fertility. The net present value of benefits from investments in cowpea research and extension in West Africa over a 20-year period from 2000 was estimated to be in the range of US$300 million─US$1 billion, with an internal rate of return ranging from 50 to 103% (Kristjanson et al., 2002).

	Production (tons)	Area (ha)	Yields (tons/ha)
World	**6,372,000**	**12,744,000**	**0.50**
Sub-Saharan Africa	**6,053,000**	**10,697,279**	**0.57**
Nigeria	3,246,617	3,434,058	0.95
Niger	1,382,219	4,681,868	0.30
Burkina Faso	539,846	1,137,333	0.47
Tanzania	180,342	228,706	0.79
Cameroon	156,239	179,761	0.87
Mali	146,925	253,128	0.58
Kenya	106,059	201,865	0.53
Uganda	85,060	70,933	1.20
DR Congo	77,604	149,305	0.52
Sudan	45,667	157,220	0.29
Senegal	42,708	112,699	0.38
Malawi	32,928	72,234	0.46
Madagascar	5,920	6,879	0.86
South Africa	4,867	11,290	0.43

Table 2: *Cowpea production, area, and yields in SSA, 2011-2013. Source: FAOSTAT (www.faostat.org).*

Over the 1990-2013 period, cowpea production in SSA grew at an average rate of 5% annually (Figure 2). Area expansion and yield growth each accounted for 50% of the growth in cowpea production in SSA. Despite these positive trends, cowpea yields still remain very low owing to a number of production constraints and to

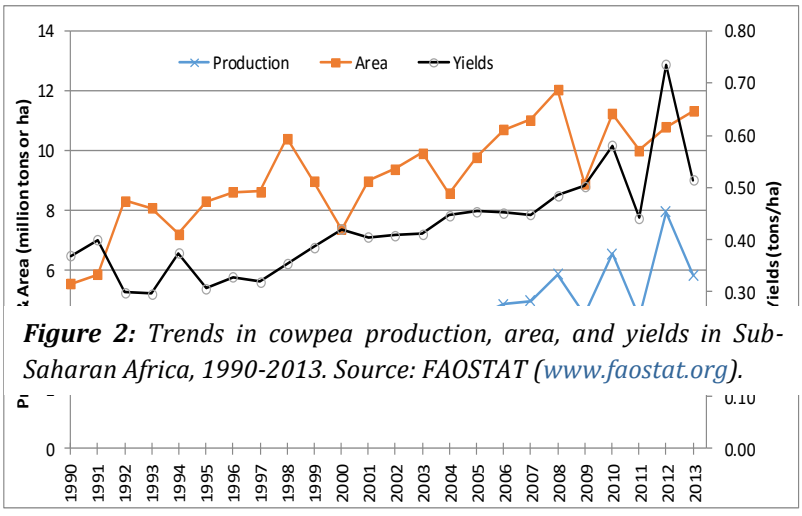

Figure 2: *Trends in cowpea production, area, and yields in Sub-Saharan Africa, 1990-2013. Source: FAOSTAT (www.faostat.org).*

low adoption of improved varieties and agronomic practices. It is expected that cowpea production will significantly increase in the coming decades as more short-duration and pest-resistant varieties become available and cowpea cultivation makes further inroads as a niche crop in the cereals and root crops-based systems.

Cowpea production will hardly keep up with growing demand. Under a scenario where future increases in cowpea production come only from area expansion, global as well as regional cowpea supply will fall short of demand. Projections for cowpea supply and demand show that global cowpea supply will reach an estimated 7 million tons in 2020 and 8 million tons in 2030, compared to projected global demand of 9 million tons in 2020 and 11 million tons in 2030. With a regional supply of only 7 million tons in 2020 and 8 million tons in 2030, compared to the projected demand of nearly 8.5 million tons in 2020 and 10 million tons in 2030, West and Central Africa will face significant deficits. Cowpea supply will grow at a slower rate (1.33%) per year than demand (2.9%) over the 2010─2030 period (Alene et al, 2012). The projections suggest that increased investments in cowpea research and extension will be vital to generating a regional surplus through increased yields, whereas regional trade in cowpea will be crucial for achieving food security through redistribution of the surplus thus generated among countries in West and Central Africa.

In Africa, women are heavily involved in grain legume production, processing, and marketing. This means that they are also the direct beneficiaries of economic benefits from research investments in these crops. There is a growing recognition that cash incomes earned and food produced by women are equitably distributed among members of the family, particularly children. In Senegal, Nigeria, and Niger, for example, processing of cowpea is common and these activities are almost exclusively undertaken by women who produce a variety of products that are sold as street food.

1.4 SHEA BUTTER

The shea grows in the dry savannas, forests, and parklands of the Sudan zone on an estimated 1 million km^2 between western Senegal and northwestern Uganda. Shea trees grow mostly in the wild in about 20 sub-Saharan African countries. These are Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Cote d'Ivoire, Democratic Republic of Congo, Ethiopia, Ghana, Guinea Conakry, Guinea Bissau, Gambia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Sudan, Togo, and Uganda. Major producing countries are found in West Africa. Available data from FAOSTAT (2013) shows that Nigeria has the highest potential for shea nut production and that high production zones include Benin, Burkina Faso, Cote D'Ivoire Ghana, Mali, and Nigeria.

In spite of the economic potential of the sheanut tree (*Vitellaria paradoxa*), its domestication still has not been achieved due to the long juvenile period of seed propagated plants and the absence of a reliable vegetative propagation method. The shea tree takes between 8 to 15 years to start bearing fruit, and reaches maturity at 20 to 30 years. The tree can continue to produce for up to 200 years. A tree can typically yield 15 to 20 kg of fresh fruit (3 to 4 kg of dry kernels), with optimum yields up to 45 kg. Raw shea nuts are predominantly harvested and dried by rural

women. If nuts are stored properly, they can last for more than a year[1]. The potential of the production capacity is not fully exploited because producers, particularly women and the private sector in countries in which shea trees grow, are not fully involved in the value addition sales of the nuts or butter. The shea sector is considered one of the promising value chains that could increase income generation for rural women. This oilseed ranks second after palm among oil crops of Africa.

Over the past decades, trade in shea butter has been on the rise because of increased demands in the European Union, Asia and the United States. This has had significant positive consequences on the local women who are the main stakeholders (95%) in the processing of shea. In addition, shea is fast becoming an export crop in many West African countries. For example, shea nuts and its products are listed among the top 10 non-traditional exports of Ghana. The shea industry, still in its infant stage, is an attractive business entity earning about US$30 million of foreign exchange for the Ghanaian national economy. This amount is expected to triple when the shea production potential in Ghana is fully exploited (Hatskevich *et al*., 2011). In Burkina Faso, shea is the fourth most important export crop after gold, cotton, and livestock and contributes about US$6 million to the national economy (Konaté, 2012). Today the shea tree is the second most important oil crop in Africa after the palm nut tree.

2. CHALLENGES

2.1 SOYBEAN

To develop a competitive soybean industry, the following strategic constraints will need to be resolved.

LOW PRODUCTIVITY AND PROFITABILITY OF SMALLHOLDER PRODUCTION SYSTEMS

A huge gap still remains between the yields obtained by researchers (>2 t/ha) and farmers (450 kg/ha). The dismal on-farm yields of soybean can be attributed to poor access to inputs--high yielding improved varieties, crop protection products, fertilizers, inoculants, lack of better crop and soil management technologies, lack of mechanization, and poor transport infrastructure, which results in high production costs. As soybean yield can be significantly reduced by drought, its production is limited to regions where there is enough rainfall to carry the crop to maturity. There are insufficient areas with favorable natural endowments to competitively produce and supply soybeans at the cost and quality of global competitors. There is a lack of profitable improved genetic and crop management technologies for expanding production to marginal areas characterized by dry land conditions without irrigation, infertile soils and severe resource constraints. The major perceived production constraint on smallholder production is dispersed land parcels that make it difficult to use machinery for harvesting to reduce losses through shattering and achieve the quality standards required by processors in a high technology soybean subsector. Many potentially high yielding varieties have been developed over the past decades by IITA, national programs and the private sector. The IITA varieties have potential

[1] USAID, "The Shea Butter Value Chain: Refining in West Africa," WATH Report, Oct 2004, p. 4

yields of 1.5-2.3 t/ha grain and 2-3 t/ha fodder. Improved agronomic practices have also been developed that can further increase on-farm yields if adopted by farmers

LIMITED KNOWLEDGE AND ACCESS TO PROCESSING TECHNOLOGY

As one of the world's major and fastest expanding crops, soybean can increase agricultural productivity and contribute significantly to the overall nutrition of Africans in terms of both calorie and protein intake. It is well placed to meet the fast growing demand for food and animal feed ingredients in developing countries. Utilization at home level and by local industries will greatly benefit African farmers and the economies of their countries. However, farmers' limited knowledge of the proper processing of soybean reduces soybean consumption, industrial use, trade, and export opportunities. Increasing the industrial and food uses of soybean through the introduction and adaptation of proper processing of soybean can simultaneously improve the welfare, food security, and livelihoods of farming communities, as well as that of the urban poor, who spend over 60% of their income on food. Recently, IITA developed technologies for production of soy-products such as cooking oil, soy-milk, soy-cheese (tofu), food condiment (*dawadawa*), and soy-cake used for industrial food and feed production. The technologies were introduced and tested in West Africa. These now provide income-generating opportunities for women involved in their production and sale and contribute to the development of SMEs in rural areas. Soybean is the base for very important industrial raw materials such as oil and lecithin for food, pomade or soap industries in West Africa. The soy-cake left after oil extraction is a world first-class raw material for feed formulation.

2.2 GROUNDNUTS

Groundnut farmers are challenged by low yields, high levels of aflatoxin contamination, and high labor costs for processing, which is traditionally done by women and children. These challenges have a direct bearing on the productivity and market competitiveness of the sector. The productivity of groundnut in Africa remains low, with yields of around 1t/ ha compared with a global average of 1.5t/ha and over 3t ha in the USA and China. Both biotic (foliar diseases such as early leaf spot, late leaf spot, rusts; rosette; aflatoxin) and abiotic stresses (drought, soil fertility and natural resources degradation) as well as socioeconomic constraints, including lack of availability and poor access to new varieties, poor access to seeds of improved varieties (groundnut is a high seed rate low multiplicative ratio crop) due to weak seed system, limited use of mechanization under conditions of limited labor availability, poor access to inputs and credit facilities, weak extension system and poorly developed market and volatile price contribute to the low productivity of the crop.

Africa's share in the global groundnut market has declined significantly in the last four decades. For example, West and Central Africa (WCA) oil export has declined from 55% to 24%; and confectionary groundnut export by 50%. The decline in export is mainly attributed to 1) the dearth of government-supported parastatal marketing organizations without a simultaneous growth of the private sector in the early years of the privatization drive; 2) less emphasis on support to agriculture as some major producing countries also discovered oil and or minerals; and, 3) poor quality standard associated with aflatoxin infection, where products from Africa fail to meet stringent quality (aflatoxin) standards set by European markets (4ppb) and many

other countries (20 ppb). The main issues concerning aflatoxin management in the project countries include the following: Lack of awareness of the effects of aflatoxins on crops, nutrition and human health at all levels (producers, buyers, traders, consumers); Lack of knowledge on appropriate technologies to mitigate aflatoxins on farms; Lack of expertise and appropriate facilities in aflatoxin analysis; Lack of knowledge in postharvest and storage management of aflatoxin in groundnut attributed to insect infestation, Aflatoxins, general quality, harvesting and storage practices; Lack of availability of the biocontrol product aflasafe and its inclusion in the aflatoxin management package and groundnut value chain; Lack of data on aflatoxin contamination along the value chain; and, Lack of premium for aflatoxin-free groundnut, and lower income for farmers

With its research programs in Malawi, Mali, Niger and Nigeria, ICRISAT has been working to address the above challenges by developing improved groundnut production and aflatoxin management technologies. IITA is leading an effort to develop a biocontrol solution using the product named aflasafe. These programs have been working with national research programs in the respective regions. Main achievements are summarized below.

- A wide range of groundnut germplasm was assembled (over 6000 accessions) and characterized and conserved in a regional gene bank at ICRISAT-Niamey, Niger. This germplasm is accessible, for utilization, to groundnut improvement programs in the region.

- Over the years, ICRISAT has developed breeding lines to share with national programs, and the national breeding programs have released more than 100 improved varieties with genetic background from the ICRISAT breeding program. These include recent releases in many countries such as ICGV86124, ICGV86024, ICGV86015 (Mali); Samnut 24, 25 26 (in Nigeria); Oboolo, Obooshi, Otuhia, Yenyawoso (Ghana) Nsinjiro, CG 7 (in Malawi); Mamane, CG 7 (in Mozambique); Igola 2, Serenut 1R (Uganda); Chishango, (Zambia); Mnanje (Tanzania).

- Current seed production and supply systems were characterized, documented and alternative strategies identified and implemented in pilot sites including small seed pack, community-based seed production, and marketing under the TL-II project. The seed delivery system is further strengthened in some African countries with specific funding agency support viz., Irish Aided Seed Project in Malawi; USAID Scaling up project in Mali, Ghana and Nigeria, and so on.

- Measures to minimize aflatoxin contamination were promoted with a combination of tolerant varieties and best-bet pre-and postharvest practices significantly minimizing aflatoxin contamination. On average, 55% of farmers exposed to improved practices produce groundnut with tolerable levels of aflatoxin compared to 7% who were not exposed.

- IITA has developed country specific biocontrol product for Nigeria, Kenya, Zambia, Burkina Faso, Senegal/The Gambia, and products are currently being developed for Ghana, Tanzania, Mozambique, Malawi, Zambia and Uganda.

- ICRISAT has developed the ELISA method for aflatoxin analysis and quantification, and has established laboratories in Malawi, Mali, Niger and Nigeria. The laboratories provide aflatoxin analysis and quantification services to partners in the respective countries, and they are also used for training research and extension personnel.

- Capacity building has been an integral part of ICRISAT engagement with various partners in Africa. In recent years, at least 1000 farmers and 20 extension agents have benefited from training in crop management practices, aflatoxin management and seed production every year with TL-II fund support in target countries. Over 100 rural entrepreneurs received training in small-scale seed business and marketing. User-friendly training guides and manuals were produced and distributed to about 5000 beneficiaries. Non-degree and degree training was conducted for national groundnut improvement programs to enhance the skills of research technicians and scientists in managing an efficient breeding program.

2.3 COWPEAS

BIOTIC STRESSES

Cowpea is attacked and damaged by insect pests from planting to storage. However, the most critical stage of insect attack is the period between flowering and pod development and during storage. Post flowering insect pests such as the legume pod borer (*Maruca vitrata*), flower thrips (*Megalurothrips sjostedti*), and pod sucking bugs (*Clavigralla tomentosicollis, Anoplocnemis curvipes and Riptortus dentipes*) can cause grain yield losses of up to 90% if appropriate control measures are not implemented (Alghali, 1992). Cowpea is attacked by a number of pathogens that include fungi, bacteria, viruses and nematodes. The most important diseases are bacterial blight, *Septoria*, and scab. Cowpea suffers considerable damage from *Striga gesneroides* and *Alectra vogellii*, with crop losses estimated at over US$200 million in west and central Africa (Singh, 2002). A number of cowpea varieties that are resistant to insects, diseases and weeds have been developed and need further testing by farmers.

LOW PRODUCTIVITY COWPEA-BASED CROPPING PRACTICES

The predominant cropping system in the dry savanna is intercropping of cowpea with cereals (millet, sorghum, maize) in various spatial and temporal arrangements. In this system, cowpea grain yields are very low (0.5 t/ha) due to shading by cereals, low plant population, low soil fertility, lack of fertilizer and insecticides, late planting, and poor yields of local varieties. Cereals are sown with the first rains and cowpeas are relayed cropped 3-4 weeks, which results in cowpeas been shaded throughout the growing season, resulting in reduced grain and fodder yield. Cereals sown at low population (to minimize shading of cowpea) results in low productivity of the system. IITA has developed improved varieties that tolerate insect pests, pathogens, and parasitic weeds and give higher yields in intercropping settings. Improved strip cropping (two rows of densely sown cereals and four rows of densely sown cowpea) have proven to be more productive and can give 100% to 300% gross economic superiority over the traditional intercropping systems (Singh and Ajeigbe, 2002).

POSTHARVEST CONSTRAINTS

Postharvest losses in cowpea occur mostly as a result of insect and fungal problems, as there are no appropriate postharvest strategies available at farm level to ensure that farmers benefit from increased crop yields. A typical example would be the loss of cowpea grain quality due to infestation with bruchids that forces farmers to sell their cowpea grain soon after harvest when the supply is plentiful and prices are low. Using a combination of improved varieties that are less susceptible to pests and low input technologies to reduce pest infestation, such as solar drying and double bagging of cowpea grain, provides farmers with the opportunity to store grain until later in the dry season when the price is higher. Providing appropriate tools and equipment for postharvest systems will result in more benefits in the use of higher yielding crop varieties and improved agronomic practices. Improving the postharvest system would stimulate production because it facilitates processing and marketing of quality crop products, expands the utilization potential of crop products and is a key to greater commercialization of different food crops in Nigeria. Over the years, IITA, in collaboration with machine fabricating firms-- and the participation of private sector—has developed postharvest machines that require low investment. Such machines are now locally fabricated and can be purchased locally by individuals or farmer groups.

LACK OF DIVERSIFIED INDUSTRIAL USES OF COWPEA

Owing to cowpea's high protein content, the crop has high potential for use as an industrial crop. Major constraints to its industrial use by food companies are lack of reliable statistics on production, strong price fluctuations during the year, low quality of raw materials in terms of physical defects and pesticide residues, and lack of primary processors, which forces food industries to process the grain. The lower protein content of cowpea compared to soybean makes it less attractive to industrial processors. There is high potential to develop industrial products from cowpea but interventions are necessary to promote and organize the supply chain and primary processing. There is potential to develop diverse food products ranging from breakfast foods, weaning foods, and other products for the confectionary industry. Furthers efforts to develop consumer-acceptable products will expand markets for cowpea.

CROSS-CUTTING CONSTRAINTS AFFECTING SOYBEAN, COWPEA, AND GROUNDNUT

POOR ACCESS TO IMPROVED SEEDS

A number of factors contribute to the failure of the existing seed system to provide smallholder farmers with access to improved varieties of oil crop and legume seeds. There is no coordinated mechanism for seed supply to producers. The publicsector has no capacity to meet the demand for new varieties and for production of foundation seed for distribution to seed producers (as priority for production of foundation seed is generally given to more commercial crops, such as hybrid maize). Competitiveness of oil crop or legume seed markets is limited by the low rate of return on investments in breeding and seed production, processing and marketing because these are self-pollinated crops and farmers can retain grain from previous harvests and recycle them. On the seed-demand side, many farmers simply do not know about new varieties (i.e. their potential advantages, where to access them, or how to manage them). Poor rural road networks increase the cost of seed due to high transportation costs. Furthermore, when the

improved seeds are available locally, they tend to be too expensive because they are sold in large packages only suitable for larger-scale farmers. Many farmers have also become accustomed to receiving free seed from NGOs and do not appreciate the investment required for high-quality seed. For all these reasons, appropriate seed systems need to be designed to meet these challenges and to reach poor farmers in more remote and less favored areas. One way of doing this is to interest commercial seed companies to invest in seed production of publicly developed varieties and work with them and other stakeholders to improve coordination along the value chain to create the necessary incentives for farmers to invest in improved seed and other complementary inputs that are needed to increase productivity and improve quality. Experiences from other parts of the world suggest that the establishment of a Foundation Seed Enterprise dedicated to production and marketing of foundation/basic seed can support the efforts of seed companies interested in commercializing improved publicly developed varieties. These efforts can be greatly enhanced if some degree of exclusivity is offered to interested seed companies. IITA has also piloted initiatives to promote seed production through community-based schemes.

LACK OF FARM MACHINERY

Despite the introduction of yield-enhancing technologies during the past three decades, labour-intensive production practices still prevail and crop products are processed manually at household level. Many farmers use labour-intensive production and postharvest techniques because they do not have resources to invest in machinery that can facilitate farming and processing of crop products. The majority of the farmers cultivate small fragmented farms, which do not favor investment in labor-saving machinery. The available household labor is usually inadequate and often limits the area that can be cultivated. Despite the increments in crop productivity through use of improved crop varieties, the payoff is still insignificant at farm level because of high postharvest losses, high labor requirements, inappropriate storage facilities and poor product quality resulting from poor harvesting and handling systems. For cowpeas, the loss from harvest through storage can be as high as 15% to 20% of the volume harvested, to which should be added the qualitative loss resulting in lower prices. A loss of this magnitude has obvious implications for income and food security for rural households and in particular for those living close to subsistence level.

LOW SOIL FERTILITY

Most tropical soils are inherently poor in soil fertility. They have low organic matter (<0.3%), are low in nutrient content, especially N and P, and are prone to erosion and compaction. Phosphorus deficiency is the most limiting nutrient for legume production (Bationo et al, 2002). Commercialization of oilseed legumes and cowpea production will certainly target the cultivation of higher yielding varieties, which will consequently have negative effects on phosphorus availability in the soil. For example, phosphorus application (rock-P or fertilizer) can result in a 12% to 52% increase in cowpea grain yields. However, inorganic amendments are hardly available in affordable quantities to farmers as a result of inefficient input marketing arrangements.

INPUT MARKET CONSTRAINTS

Accelerating agricultural growth requires the use of the science and technology embodied in improved seed, fertilizers, crop protection products, and novel agronomic practices. This requires an efficient and cost-effective input supply system. However, agricultural input markets are fragmented and underdeveloped in most countries. Input market reforms introduced in the 1990s without developing adequate supporting institutional and human capacity decreased the use of fertilizers, pesticides, and improved seeds. The transaction costs of acquiring inputs are currently very high and the inputs are often not readily available when required and may not be of acceptable quality. Resource-poor farmers cannot afford to purchase inputs because they do not have access to credit institutions. Lack of proper regulation has led to widespread use of outdated or adulterated pesticides and fertilizers, which endanger human health and the environment.

OUTPUT MARKET CONSTRAINTS

Smallholders have not been able to respond effectively to available soybean market opportunities because of a number of structural and institutional constraints that limit market participation. Market failure caused by high transaction costs, imperfect and asymmetric information, risk and problems of contract enforcement are widespread in rural areas. Processors and traders are constrained by low quality grain, inadequate supply, and high cleaning costs whereas market intermediaries in the supply chain face high assembly costs, high market risk and cash flow problems. These factors undermine private sector incentives for improving markets and act as a disincentive to farmers to produce and supply quality products with desirable market traits. This points to the vital need to organize and build the capacity of small farmers, which will help them access essential services, improve competitiveness, and penetrate markets. Overcoming these constraints calls for multiple interventions. On the supply side, research needs to determine market preferences and quality standards as well as options for enhancing quality, volumes and reliability of supplies. On the demand side, research needs to identify niche markets and strategies for reducing price variability. Improving market access and the competitiveness of smallholder farmers will also require new kinds of market institutions that facilitate formation and enforcement of contracts and enable vertical and horizontal coordination of production and marketing functions. This will require careful analysis of the soybean sub-sectors; and enhanced understanding of the structure and functioning of input and output markets, including value chains, supply constraints and transaction costs for alternative marketing channels and supply chains.

A major area that has been neglected or given low priority is the development of an active market information system. Since every stakeholder in the agricultural market chain will need information about local, regional, and even global prices, stocks, and availability of inputs and outputs in various markets, a market information system (MIS) is crucial for the functioning of the market. Although commodity marketing is liberalized in some countries, the atomized and un-integrated production and marketing system causes a major bottleneck for small-scale farmers. An effective MIS will capture information on product standardization, price and pricing, inventory levels, product range, utilization possibilities, alternative markets for products and price profiles, and so on. The existence of strong marketing structures is also imperative for farmers to maintain cash crop production and soil management through access

to credit, research and extension services. The need to strengthen trade associations to effectively use MIS is necessary to promote sustainable inter and intra-regional trade.

LOW LEVELS OF TECHNOLOGY ADOPTION

CGIAR member centers and their partners have made significant advances the development and release of a number of improved varieties suitable for a range of agroecologies throughout SSA. A number of socioeconomic and targeting studies (http://www.icrisat.org/impi-tl-2.htm) show that adoption of new varieties has been low and slow, with old varieties that were released 15─20 years ago still occupying much of the area under production. Adoption of improved varieties is mostly limited by lack of access to information on available varieties and inadequate seed supply. It has been shown that the major drivers of dissemination of research products and of adoption by farmers are the latter's awareness and access to new information ; expected benefits and local availability of new technologies; market access and opportunities; and access to credit and other policies that enable farmer investment in new technologies. Although constraints outside the research system provide much of the explanation for the low adoption of cowpea and soybean varieties, there are also adoption constraints within the research system. The uptake of technologies by farmers depends largely on whether a particular technology addresses key production constraints farmers are facing and has the traits that are highly preferred by various end users. A growing volume of empirical work has demonstrated that farmers are unlikely to adopt new varieties that do not meet their own criteria or address major production constraints. While other institutional and policy factors may hinder the uptake of otherwise profitable varieties and practices, addressing the needs and priorities of smallholder farmers and other actors along the value chain is the necessary condition for greater technology uptake and impacts.

2.4 SHEA BUTTER

Shea butter production, processing, and marketing face the following contraints:

- Lack of value addition: This is the major constraint in expanding shea nut processing and marketing. The concept of value addition is a vital component for addressing global market competition, postharvest losses, and food security. Value addition promotes market acceptability and gives the products high economic value which consequently brings higher income to the producer. Though efforts are being made continuously to improve shea butter production methods, accessibility to these improved methods still remains low. The majority of the processors still use traditional techniques that are inefficient and lower the quantity and quality of shea butter available in the market;

- Plant regeneration and maturation: This is another major constraint:: shea trees grow mostly in the wild and produce the first fruits after 10–15 years. Natural regeneration has declined in most of the countries where they are grown and the capacity for research in shea regeneration is weak. Consequently, research on domestication of the plant and development of improved cultivars for sustainable future performance is very limited. Also, deforestation (indiscriminate burning of bushes and cutting of trees) coupled with

population increase and expanding agricultural land clearing have led to degradation in some shea producing areas, except in those where the shea trees are protected.

- Weak linkages between private sector actors. Although there is substantial market potential for the shea sector, value chain stakeholders perceive a multitude of constraints that hinder the development of the shea sector: (i) poor storage leading to low quality—this causes nuts to form mildew and rot before they can be processed. For West African producers to export high-quality shea butter, storage techniques must be improved; (ii) postharvest processing-- currently, low quality techniques, such as smoking nuts over a fire, contaminating them with hydrocarbons, are used; (iii) lack of access to financing--most shea butter producers have little access to production and marketing capital. Women who harvest shea lack cash flow, which causes them to sell early, before the nuts are properly dried. Since drying significantly increases the quality of the nut, these women must sell at a much lower price, reducing their potential earning power.

- Sustainable access to markets - Few female producer groups have long-term, reliable commercial relations with buyers of shea butter or with export markets, and there are few incentives for quality control.

- Certification of shea kernel and butter has become increasingly important for a number of reasons. Since 1 January 2005, the EU has demanded that all agricultural products, including shea nuts, should be traceable from source. Furthermore, a number of cosmetic companies are asking for organically certified shea butter for the formulation of organically labeled 'botanical' products. Demand for consistent 'Quality @ Quantity' is increasing the need for quality assurance. Finally, there are indications that the main problem encountered with export of shea products is aflatoxin content in the nut while in storage. Quality assurance for shea products to meet importers' requirements is becoming an increasingly complicated and highly technical issue for which producers need to develop expertise to safeguard and increase market penetration.

3. OPPORTUNITIES

AVAILABILITY OF PROCESSING, MANUFACTURING AND INDUSTRIAL COMPANIES

For soybean and groundnuts (sometimes cowpeas), the first opportunity is the value addition in the processing of oil crushing, processing and manufacturing and retailing feed, food and industrial products in response to the large and growing domestic demand for soybean products. Oilseeds have high value because of their high protein and oil content. They can be used to produce many products and develop many industries. Oil seed processing industries have strong backward linkages with industries that supply agricultural inputs to farmers, on-farm production and output marketing; and forward linkages with industries that use animal feeds and industrial products and retail food products. The poultry feed industry has especially important opportunities because of the large and rapidly increasing demand for soybean meal and poultry products, excess demand for soybean meal and poultry currently being met through imports, and stock feeds and food manufacturing firms now looking at sourcing soybeans from domestic

growers. In turn, the development of the poultry industry generated employment and income opportunities.

AVAILABILITY OF HIGH- YIELD VARIETIES AND CROP MANAGEMENT TECHNOLOGIES

The availability of improved locally adapted genetic and crop management technologies, experienced farmers, and resources, is the second opportunity to be explored by this project. New varieties are becoming available with improved oil products. Reduced tillage and no till technologies, herbicides and precision agriculture are being rapidly adopted by farmers. These new technologies will be key factors in increasing productivity growth and catching up with lowest cost global producers. For example, soybean production costs are about US$350 per ton are competitive with recent high international soybean prices exceeding US$400 since the beginning of January 2007.

PUBLIC-PRIVATE INSTITUTIONAL ARRANGEMENTS

Institutional arrangements to bring together small scale and large commercial farmers' cooperatives, municipalities, government departments, science and technology research and development councils, agribusiness firms and government agricultural development programs as partners in developing soybean value chains are vital. One of such institutional arrangement is contracting between large-scale and small-scale farmers to consolidate landholdings and achieve economies of scale through mechanized harvesting and provide mentorship for smallholder farmers to do commercial farming on their own. This is already happening in some parts of Africa through joint ventures between smallholders and agribusiness firms.

SOIL FERTILITY ROTATIONAL BENEFIT

Expanding the areas cropped to soybeans and cowpeas will permit farmers to save on nitrogen fertilizer costs--a significant benefit given the soaring international prices of inorganic fertilizers.

HARMONIZATION OF VARIETY REGISTRATION

This initiative will be important especially in West, Southern and COMESA region, which will facilitate widespread availability of improved seeds.

EMERGING DEMAND FOR SOYBEANS FOR FEEDSTOCK FOR BIO-DIESEL PLANTS

Biodiesel plants have the potential to expand markets, increase the price of soybeans and improve the profitability of soybean production. Large-scale commercial farmers can respond to the higher soybean prices by increasing supply— and earn higher incomes. Spillovers to smallholders will stimulate a supply response, thereby increasing the livelihood incomes of rural poor households and reducing poverty through higher land values and rentals. When biodiesel is produced from soybean, by-products are used in animal feed and food industries, thereby increasing the production and consumption of poultry and food products.

AFLATOXIN MANAGEMENT FOR GROUNDNUTS

Pre- and post-harvest technologies are available to manage aflatoxin infestation to acceptable levels. These include use of farmyard manure, use of crop residue, use of lime (depending on availability), use of information on Good Agricultural Practices (GAP), Aflasafe, use of resistant tolerant varieties, harvesting time, proper drying methods and storage. Promoting some

of these available aflatoxin mitigation technologies will have a big impact in reducing aflatoxin contamination thereby improving the marketability of groundnuts. The reduction of mycotoxin risk (via aflatoxin mitigation technologies) will also help farmers have safer food and therefore improved health.

MECHANIZATION FOR TIMELY PLANTING/HARVESTING AND PROCESSING OF GROUNDNUT

For the most part, farmers are poorly equipped with agricultural implements. In Mali, for example, most of the farmers (about 80%) own hand tools and less than 5% own a complete set of animal traction equipment (a pair of bullocks, a plough, multipurpose equipment, and a seeder) for production. In many countries, harvesting is largely done by hand, mainly by women, and processing is done with rudimentary tools not amenable to large-scale processing at the local level. The low level of equipment has significant implications on the potential for expanding groundnut cultivation in the country.

Groundnut production is a labor-intensive process such that returns to labor for groundnut crop enterprise may be lower than the opportunity cost of labor. In this case, the returns to investment in small mechanization, in the form of simple animal traction, may be high. Access to production and processing equipment such as shellers and pod strippers will improve efficiency, reduce labor demand and minimize drudgery to women while increasing the productivity and profitability of the groundnut sector.

HIGH DEMAND FOR COWPEA GRAIN IN NIGERIA

Nigeria alone has unmet demand for cowpea. The national consumption is more than 3.5 million MT. The shortfall is supplied by neighboring countries— Niger, Cameroon, and Burkina Faso. Demand for the crop in Nigeria is estimated to rise each year by 3.6% and the country is expected to continue to be a net importer until year 2020 and even beyond. The country currently spends over $628 million US dollars on cowpea importation to meet national needs. Production in Ghana is expected to increase by 11.1% between 2010 and 2020. In Burkina Faso, about 380,000 MT are produced each year from 804,000 hectares. The bulk is consumed locally, and the excess exported to Nigeria. National demand for cowpea in Burkina Faso is expected to increase at a rate of 3.87% due to an increase in population and income. In other parts of Africa, Mozambique and Tanzania produce the highest amount of cowpea. The crop has the potential to grow and give farmers some yield in drought-prone areas where many other crops suffer heavy yield losses due to drought stress.

DEMAND FOR SHEA IS INCREASING

Demand for shea products has grown in the European Union, Asia, and the USA necessitating that African countries go into export. The rise in demand stems from the fact that cosmetics and personal care companies have increased the use of shea butter in their products. It is estimated that in 2007, six major companies in the international market (in the European Union and the USA) bought 60% of the nuts and half of the butter produced. Four major players control the refining of shea in the world market. They are, of capacity, Aarhus United in Denmark, Fuji Oil in Japan, Karlsham AB in Sweden, and Loders Croklaan in Holland (Addaquay, 2004).

There is also a potential for national and regional markets. For example, Lovett (2004) suggests that domestic markets consume about 55% of the total shea kernel and shea butter produced, while 45% is exported. Other estimates show that over 75% of all kernels and shea butter produced in sub-Saharan Africa is consumed within Africa. Important local markets include Accra, Abidjan, Abuja, Dakar, Bamako, Ouagadougou, Lomé, Cotonou, Lagos, Nouakchott, Banjul, Niamey and Conakry.

This has had significant positive consequences on local women, who are the main stakeholders (95%) in the processing of shea. In 2013, the Global Shea Alliance (GSA) estimated that 350,000 MT of shea kernel are exported from Africa annually, with a market value of approximately $120 million (based on current prices of about $450 mt). Major exporting countries include Ghana, Burkina Faso, Côte d'Ivoire, Mali, Benin, Togo, and Nigeria[2].

There is scope for involving women and youth in the collection, processing, and marketing of shea products. The level of participation in shea production is significant throughout the region but has not included measurable amounts of value addition at the regional level. Opportunities to increase exports of shea kernels and to increase local value added should be further supported. This is a value chain that can, if well-organized at national and regional levels, provide opportunities for growth and employment.

4. SUGGESTED ACTIONS/WAY FORWARD

The growing domestic and regional demand for oilseeds and legumes is unlikely to be satisfied through domestic and regional production without major research and development investments aimed at raising the productivity, profitability, and competitiveness of smallholder production systems. Such investments would have impressive expected impacts on economic growth and poverty reduction, but considerable challenges will have to be overcome if research and development products are to reach the majority of producers and small-scale processors. Overall, there is need for strategies and policies aimed at achieving large-scale adoption of yield-enhancing production technologies. Efforts should be made to promote further increases in production through cost-reducing technological change and increased investment in infrastructure and services that promote adoption of improved technologies. Increased domestic production and processing of oilseeds, for example, means that Africa can reduce its growing import bills for vegetable oil and related imports through increased production of soybean for import substitution. Four strategic interventions are suggested:

STRATEGIC INTERVENTION 1: FACILITATE EFFICIENT LEGUME AND OIL SEED DELIVERY SYSTEMS FOR SMALLHOLDER FARMERS

Despite a large number of released improved varieties, their impact has yet to be fully realized by resource-poor farmers owing to inadequate supply of quality seeds because of inadequate

[2] Trade Hub and African Partners Network. "Value Chain Assessment Reports: Overview." Prepared for the Trade Hub and African Partners Network by Abt Associates Inc., Bethesda, MD, in collaboration with J.E. Austin, Arlington, VA, May 2014.

seed delivery systems. In many instances, farmers use farm-saved seeds of low-yielding varieties because seeds of improved varieties are not accessible. Increased adoption of high-yielding varieties and other inputs will require effective and efficient seed systems. There is a need to design and implement alternative seed delivery mechanisms, such as community-based seed production and dissemination schemes, with appropriate institutional innovations to facilitate their evolution into more formal and sustainable seed delivery mechanisms. Seed sector constraints of oil crops or legumes across Africa can be categorized as technical and institutional issues including seed production and delivery system. Availability of, access to, and use of, seeds from adapted and farmer or market preferred varieties is key to realizing the impacts of investments in agricultural research and in realizing better rural livelihoods.

With respect to shea butter, there is need to domesticate shea tree efforts: investment should be made to domesticate the shea tree through research and development of modern propagation techniques. Also, an awareness campaign is necessary to encourage the conservation— for future exploration— of natural plant populations by the local communities.

Key activities will include (i) identifying available varieties (local and improved varieties) for productivity, storability, nutrient value, and preferred end-user traits, and selecting the most promising varieties for introduction to target areas; (ii) supporting the production of breeder, foundation and certified seeds using public-private partnership arrangements that will ensure sustainability of seed systems; (iii) strengthening seed certification systems; (iv) facilitating the establishment of community but private-based seed production schemes and the maintenance of strategic stocks of the seeds best suited for each category of end-users; (v) investigating options for best storage, handling, and packaging methods at community level to facilitate delivery of high quality raw materials to the pilot processing sites and to the market of choice; and (vi) introducing improved machinery for cleaning, grading, packaging and storage to improve quality seeds. Expected benefits include (i) sustained supply and adoption of improved seeds by farmers; (ii) vibrant seed sector responding to the actual needs of famers; and (iii) income generation opportunities for all stakeholders.

STRATEGIC INTERVENTION 2: VALIDATE AND PROMOTETECHNOLOGY TO IMPROVE PRODUCTIVITY, COMPETITIVENESS AND PROFITABILITY OF OILSEEDS AND LEGUMES

Lack of viable technology delivery systems has been one of the major bottlenecks affecting the uptake of improved technologies. This includes seed, fertilizer and other input delivery systems, as well as access to essential finance and services that facilitate and support technology adoption. This strategic intervention will assist partners to test and promote farmer- and market-preferred crop cultivars and associated crop and pest management practices that optimize the productivity in smallholder farmer fields. Integrated pest management practices, especially for the major pod borer pests that affect cowpeas, will be developed in close conjunction with the breeding efforts. With the advent of modern digital communication, molecular, and mapping tools, IITA with its partners is well-positioned to develop "Precision IPM" strategies. Precision IPM, like precision agriculture, leverages these modern tools to formulate recommendations for integrated pest control that are tailored to individual farmer's needs and resources. The recommendations must be easily understandable and implementable. The control options include insect-resistant crop varieties, mixed cropping systems, the judicious and safe use of

synthetic pesticides, biological controls, and biopesticides. Improved soil and crop management will be enhanced to optimize the productivity of the improved varieties under farmer conditions in the targeted countries.

With respect to shea butter, there is need to improve the quality and volume of products - the technological improvement, development and acquisition of improved production equipment, mechanization of several production stages to reduce work strain, systems of quality control as well as the construction of infrastructure and layout of adequate production spaces are important and will contribute to the development and prosperity of women's economic activities. Also needed are improvements in current practices for quality control for shea products, with a focus on field-level production, processing, storage and transport to ports of export, improvements to meet importing country standards; and a robust field quality control system for shea products for export, and a rapid aflatoxin surveillance system and traceability system within the shea production and supply chain.

Key activities that need to be implemented to achieve the strategic intervention are (i) identification of geographic clusters for the promotion of production oilseeds and legumes. Such geographic clusters should be identified based on variables such as agro-ecological conditions favorable for crop production, availability of road infrastructure, proximity to markets, availability of labor and potential for the establishment of economies of scale in production and marketing through the formation of farmer organizations; (ii) validation of new technologies (cultivars, fertilizers, pesticides and other IPM strategies) aimed at overcoming specific constraints in the geographic clusters; (iii) promotion of participatory on-farm dissemination of promising technologies; and (iv) facilitation of partnerships between private and public sectors specifically oriented to the development of sustainable input supply systems including the manufacture, distribution and marketing of aflasafe. Benefits will include sustained input supply systems, better access to high yielding varieties, improved agronomic, IPM, and postharvest practices and ability to negotiate for better produce/product prices; increases in productivity, and job creation opportunities that will have direct impacts on reducing poverty.

STRATEGIC INTERVENTION 3: EXPAND POSTHARVEST PROCESSING AND MARKET OPPORTUNITIES

Major inefficiencies exist in smallholder-scale oil crop value chains, indicating the need to provide smallholder farmers with practical cost effective technologies and new market opportunities. Net value gained by smallholders is diminished by the relatively high prices that they must pay for essential inputs such as fertilizer and improved seed; and/or much value is foregone through low yields when farmers cannot access or afford enough of these inputs. Smallholders are especially disadvantaged because they have limited access to markets and often sell immediately after harvest, when prices are lowest. Smallholders usually sell their produce with high content of shriveled, discolored and even mycotoxin-affected grains due to poor postharvest handling and especially lack of storage conditions. Processing losses are high due to inefficient tools and lack of appropriate processing machinery. Farmers have little access to information on prices, and supply and demand conditions. They sell to middlemen who pay them the lowest possible price. Women tend to be marginalized from the higher-income

generating processes of the value chain. Given this background and examples of successful interventions in value-chain for oil crops leading to market linkages, this strategic intervention will be important in achieving the overall goals of the project. For example, considerable effort is being made to improve the domestic cowpea value chain in Nigeria, including the development of new commercial food enterprises. These examples of successful interventions using the value chain approach—resulting in enhanced benefits for smallholder farmers, especially women— justifies the relevant interventions at the farm level to minimize postharvest losses, develop and provide primary processing technologies for value addition, enhance quality of produce, organize farmers into cooperatives to leverage their collective strength and enhance their capacity to engage with different stakeholders of the value chain and hence demand appropriate market prices for their produce. Ultimately, linking farmers to the local markets and in turn linking them to the overall trade in oil crops or grain legumes is key to improving their livelihoods.

With respect to shea butter, there is need to set up product marketing mechanisms that provide better access to markets to guarantee sustainable income for women; organize and group women into cooperatives to give them more trade power and increase their capacity for mutual assistance and support, and increase their production and marketing skills. Access to better-paying markets and the guarantee of selling their products should provide the means to motivate, mobilize, and encourage women in their efforts to offer quality products. Therefore, it is imperative to make sure that there is real demand at outset. This can be done by drawing on knowledge and understanding of internal dynamics that may have an impact on the activity. This includes knowing the market dynamics, policy frameworks and main bottlenecks of the particular subsector.

In addition, for shea butter, access to credit is an indispensable means to support the development of women's economic activities. Obtaining credit should enable them to support production, including an increase in quantities, to meet market requirements. Also required is the enhancement of public-private partnerships at all levels - the development of the shea sector requires the participation of the private sector to help boost the sector. Particular attention should be given to the development of the local industry - the development of the domestic industry can play a leading role in guaranteeing prices for farmers and providing competition for international demand.

In summary a value chain approach, which includes engaging all important stakeholders, with the aim of strengthening the processing and marketing capacity of small holder farmers--especially focusing on reducing the burden on women and providing them with access to higher income-generating opportunities— needs to be undertaken under this strategic component on processing and markets. This approach is likely to ensure inclusive market-oriented development of smallholder farmers and help them escape poverty.

Key activities will include (i) introducing and testing small-scale industrial processing; (iiadapting and making prototypes of processing machines for household-level and small-scale processing and cleaning— in collaboration with local fabricators,; (iii) organizing pilot operations, providing facilities to processors at pilot centers, and introducing the novel soybean

processing technologies for the supply of intermediate soy-products to markets of interest; (iv) making pilot centers operational, and delivering intermediate products from the pilot centers to end-users for testing as a strategy to create new niche markets for soybean through its integration as an acceptable raw material in industry for the manufacture of food and feed; (v) setting up systems for product aggregation, packaging, quality assurance, grading, and standardization in the supply chain system to ensure a regular supply of acceptable quality and quantity to end-users and exporters; and (vi) introducing and testing, at a pilot scale, warehouse receipt systems aimed at facilitating trade for small-scale cooperative farmers and processors involved in the aggregation of products from oil crops and legumes. Expected benefits include: (i) increased availability of a range of marketable products; (ii) creation of local employment opportunities -- resulting in reduced exodus of young people to urban areas; and (iii) increased trade in intermediate and final products from cowpea and other crops.

STRATEGIC INTERVENTION 4: CAPACITY AND INFRASTRUCTURE DEVELOPMENT TO ENHANCE KNOWLEDGE SHARING

To be most effective in reaching end-users, partners must have the required capacities to actively participate in and derive benefits from research and development activities. This strategic intervention will employ the most effective and efficient capacity building strategies. These will be at various levels, from technicians working in the labs and fields, to undergraduate and graduate students, to scientists, extension agents, and other key participants. A more coordinated approach to capacity building is envisioned where training programs and workshops cut across crops, regions and partners and can be organized collectively with focus on the highest priority needs. Producers, processors and others must be involved, not only in training on participatory research methods and other training opportunities, but also as knowledge/expertise providers to others. Courses/ programs will be designed and conducted where good exchange of ideas and solutions among all participants is possible; opportunities for learning while doing are available;, and emphasis is placed on individual hands-on learning experience for technicians and scientists from the NARS system.

Key activities will include developing training modules for all categories of stakeholders, including farmers, processors/potential processors, women's groups, agricultural extension officers, marketing groups, and interested companies/individuals and carrying out training programs for all categories of stakeholders in processing and production techniques, proper implementation of a pilot processing operations, market identification, business management, credit management, group organization/management, and micro-enterprises, to understand the basic principles of liberalized markets and the new role that they need to play under such a system, particularly in price negotiation. This strategic intervention will also invest in developing infrastructure that will be necessary to facilitate implementation of all planned activities such as irrigation, storage, pilot processing centers etc.

The capacity of women's groups on optimal production techniques and on organizational management should be strengthened. This should include training on improved techniques, for example, for shea kernel collection, processing and butter production, rice parboiling and processing techniques, community outreach, operating and managing groups and unions, governance, administrative and financial management, as well as literacy.

IMPLEMENTATION STRATEGIES

This project will be implemented in at least 20 countries in SSA. IITA and other CGIAR centers will provide technical oversight but day to day implementation will be in the hands of the private sector, national programs, and farmer organizations. Regional bodies such as COMESA, CCARDESA, WECARD/CORAF and ASARECA will have a coordination role to avoid duplication of efforts and to facilitate exchange of experiences and lessons.

5. ESTIMATED COSTS

The budget for soybean, groundnut and cowpea over 5 years covering 20 countries is estimated at US$ 889,372,674 (US$ 44.5 million per country) and the detailed budget is attached as Annex 1. The budget for shea butter over 5 years, covering 6 countries is US$300,000,000 (US$ 50 million percountry) and the detailed budget is attached as Annex 2. Total budget for all four crops over 5 years is US$ 1,189,372,674.

REFERENCES

Alghali, A.M. 1992. Onfarm evaluation of control strategies for insect pests in cowpea with emphasis on flower thrips, *Megalurothrips sjostedti* Trybom (Thysanoptera: Thripidae). Troprical Pest Management 38: 420-424

Akinola, A.A., A.D. Alene, R. Adeyemo, D. Sanogo, and A.S. Olanrewaju (2009). Impacts of soil fertility management research in West Africa. African Journal of Agricultural & Resource Economics 3(2): 159–175.

Alene A.D., Coulibaly, O. and Abdoulaye T. 2012. The world cowpea and soybean economies: Facts, trends, and outlook. Lilongwe, Malawi: International Institute of Tropical Agriculture.

Alene, A.D. and V.M. Manyong. 2006. Farmer-to-farmer technology diffusion and yield variation among adopters: the case of improved cowpea in northern Nigeria. Agricultural Economics 35: 203–211.

Alene, A.D., V.M. Manyong, E. Tollens, and S. Abele (2009). Efficiency–equity tradeoffs and the scope for resource reallocation in agricultural research: evidence from Nigeria. Agricultural Economics 40(1):1–14.

Bationo, A., B.R. Ntare, S.A. Tarawali and R. Tabo (2002) Soil fertility management and cowpea production in the semiarid tropics. Pp 301-318. In C.A. Fatokun, S.A. Tarawali, BB. Singh, P.M. Kormawa and M. Tamo (eds) Challenges and opportunities for enhancing sustainable cowpea production. Proceedings of the world cowpea conference III held at the International Institute Tropical Agriculture (IITA), Ibadan, Nigeria, 4-8 September 2000. IITA, Ibadan, Nigeria.

Sanginga, N., K.E. Dashiell, J. Diels, B. Vanlauwe, O. Lyasse, R.J. Carsky, S. Tarawali, B. Asafo-Adjei, A. Menkir, S. Schulz, B.B. Singh, **D. Chikoye**, D. Keatinge, and R. Ortiz (2003) Sustainable resource management coupled to resilient germplasm to provide new intensive cereal-grain-legume-livestock systems in the dry savanna. *Agriculture, Ecosystems and Environment 100: 305-314.*

Singh, B.B. and H.A. Ajeigbe. 2002. Improving cowpea-cereals based cropping systems in the dry savannas of West Africa. In C.A. Fatokun, S.A. Tarawali, BB. Singh, P.M. Kormawa and M. Tamo (eds) Challenges and opportunities for enhancing sustainable cowpea production. Proceedings of the world cowpea conference III held at the International Institute Tropical Agriculture (IITA), Ibadan, Nigeria, 4-8 September 2000. IITA, Ibadan, Nigeria.

Trade Hub and African Partners Network. 2014. Value Chain Assessment Reports: Overview. Prepared for the Trade Hub and African Partners Network by Abt Associates Inc., Bethesda, MD, in collaboration with J.E. Austin, Arlington, VA.

USAID. 2004. The Shea Butter Value Chain: Refining in West Africa. WATH Report, p. 4.

World Bank (2009). Awakening Africa's Sleeping Giant: Prospects for Commercial Agriculture in the Guinea Savannah Zone and Beyond. Washington, DC.