Development of improved soybean varieties adapted to the agro-ecologies and farming systems of the Savanna zones of northern Ghana.
Nicholas N. Denwar and Zackariah Wohor

Executive Summary
The importance of soybean in the farming systems of northern Ghana cannot be downplayed. Soybean has high levels of protein, oil and some essential amino acids needed for growth and development. As a legume it fixes nitrogen which complements the low level of chemical fertilizer application. Again, the haulm is used to feed small ruminants during the dry season when natural pastures are burnt by the annual bushfires. Northern Ghana is also plagued with the menace of Striga hermonthica, a parasitic weed that is endemic in many areas, with the potential to cause complete yield loss in cereal crops under severe infestation. The Soybean Improvement Programme of SARI has, over the years, made efforts to minimize the effects of this parasitic weed by developing and testing improved lines that are efficacious as trap-crop and also have comparable yield potentials as the existing cultivars with the aim to increasing maize productivity through the use of soybean as a trap-crop in complementation with Striga and drought tolerant maize lines. Efforts were also directed towards reduction of the maturity period of commercial varieties available to farmers in order to fit the crop into the dwindling rainfall regime, particularly in the Sudan Savanna agro-ecological zone. Following results of on-farm tests with selected promising lines conducted throughout northern Ghana to determine their performance and acceptability to farmers, two medium (110-120 days) maturing lines bred with enhanced abilities to control Striga and two early (85-90 days) maturing lines were proposed to the National Variety Release and Technical Committee for consideration for release to farmers in 2012. After careful consideration, three of them were accepted and released in December, 2012. These were Afayak (TGX 1834-5E) and Songda (TGX 1445-3E), both excellent trap-crop for Striga, and Suong-Pungun (TGX 1799-8F), an early maturing variety (90 days). Plans were made to produce breeder seed of these new materials under irrigation to ensure availability of breeder seed for foundation seed production by private seed companies during the 2013 main cropping season. Part of the seed will also be used for demonstrations across northern Ghana. Factsheets and production guides would also be produced to facilitate the production process by farmers, extension agents and seed companies.

Introduction
The three regions of northern Ghana constitute about 40% of the total land mass of the country with a population close to 4 million people, 70% of whom live below the poverty line. Agriculture is the dominant economic activity in the area, employing about 80% of the population. However, agricultural productivity in the area is low, attribut Table to the over-dependency on rain-fed subsistence agriculture and low external inputs application to the largely degraded and infertile soils. As a result, widespread hunger, malnutrition and food insecurity are prevalent, leading to high rates of infant mortality and economic decline.

Soybean is an important source of high quality and relatively inexpensive protein and oil, containing about 40% protein and 20% oil. Soybean has superior amino acid profile in that it contains such essential amino acids as lysine and tryptophan. The crop, being a legume, has considerable capacity to fix nitrogen and that put it in good stead as an integral part of subsistence agriculture. The menace of the parasitic weed Striga hermonthica further reduces maize yields as resistant maize varieties are non-existent. However, the yields of current soybean varieties are just above break-even levels while the capacity to stimulate suicidal germination in S. hermonthica seeds is low. The importance of soybean as a food and cash crop in rural communities is growing, occupying the third place after groundnut and cowpea. With the proliferation of soybean processing plants in Ghana of late its potential as a poverty alleviation and wealth creation crop cannot be over-emphasized.

The main goals of the Soybean Improvement Programme are to develop varieties that are suited to the agro-ecological conditions as well as the major farming systems in the interior Savanna zone of Ghana, transfer appropriate technologies to farmers for the realization of food security of farm-families and thereby create wealth in the country.

Materials and Methodology
The trials comprised of 12 early and 15 medium/late maturing lines tested across 3 locations.
Design: RCBD with 4 replications
Plot size: 4 rows, 5 m long
Spacing: 75 cm x 5 cm (medium/late); 60 cm x 5 cm for early lines.
Results and Discussion

Scientific findings

1. Germplasm introduction and preliminary evaluation: Two sets of trials, comprising 18 early and 17 medium maturing lines were introduced from IITA and evaluated in preliminary trials. Four lines were selected based on yield, earliness and seed quality.

2. Advanced yield trials of medium/late soybean lines were composed and planted at test sites in Nyankpala, Damongo, Yendi and Manga for 2012. These included F₄ segregating generations of crosses made between pod-shattering resistant varieties Jenguma and Quarshie and high stability, longer maturing, shattering susceptible cultivar Salintuya-II. Individual plants were selected and bulked to form a population.

3. Response of Soybean to fertilizer and Rhizobium inoculum in Northern Ghana -2012

Objectives: To assess the agronomic and economic benefits of using fertilizer and rhizobium inoculum on soybean production. Preliminary results indicate that grain yield advantage of inoculation was not clearly differentiated from chemical fertilizers, but both had significant advantage over no fertilizer application.

Technology Developed: Two early maturing lines, TGX 1799-8F and TGX 1805-8F, and two medium maturing lines, TGX 1834-5E and TGX 1445-3E, which are efficacious for causing suicidal germination of Striga seed, were proposed to the National Varietal Release and Registration Committee for consideration for release in 2012. Except TGX 1805-8F, the others were accepted and released. Their descriptors are given below.

Scientific Name: TGX 1799-8F
Given Name: Suong-Pungun
Maturity Period: 85-92 days
Yield Potential: 1.5-1.8 t/ha
Pod Shattering Score: less than 10%
Special Attribute: Earliness over previous varieties (90 compared to 115 days)
Consumer Preference: Very Acceptable
Benefit/Cost Ratio: 1.63
Preferred Ecology: Broadly Adapted

Scientific Name: TGX 1834-5E
Given Name: Afayak
Maturity Period: 110-115 Days
Yield Potential: 2.0–2.2 t/ha
Pod Shattering Score: Less than 8%
Special Attribute: Excellent for Striga control (as a trap-crop)
Consumer Preference: Very Acceptable
Benefit/Cost Ratio: 2.04
Preferred Ecology: Broadly Adapted

Scientific Name: TGX 1445-3E
Given Name: Songda
Maturity Period: 110-115 Days
Yield Potential: 1.8 – 2.2 t/ha
Pod Shattering Score: Up 20%
Special Attribute: Excellent for Striga Control (as a trap-crop)
Consumer Preference: Very Acceptable
Benefit/Cost Ratio: 1.12
Preferred Ecology: Broadly Adapted
Technology transferred: Breeder seed of released and promising lines was produced for distribution to private seed companies and individual farmers and seed growers for the production of foundation and certified seed for cultivation by farmers. Table 8 shows the breakdown of the quantities of the various varieties and lines produced.

Table 8: Breeder seed production of released varieties and promising lines of soybean by the Legumes Improvement Program of SARI for 2012.

<table>
<thead>
<tr>
<th>Location</th>
<th>Variety</th>
<th>Maturity</th>
<th>Status</th>
<th>Yield (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nyankpala</td>
<td>Jenguma</td>
<td>Medium</td>
<td>Existing cultivar</td>
<td>1200</td>
</tr>
<tr>
<td></td>
<td>Quashie</td>
<td>Medium</td>
<td>Existing cultivar</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td>Afayak</td>
<td>Medium</td>
<td>Released, 2012</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Suong-Pungun (TGX 1799-8F)</td>
<td>Early</td>
<td>Released, 2012</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>TGX 1805-8F</td>
<td>Early</td>
<td>Release deferred</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Salintuya-I</td>
<td>Medium</td>
<td>Existing cultivar</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>Salintuya-II</td>
<td>Late</td>
<td>Existing cultivar</td>
<td>400</td>
</tr>
<tr>
<td></td>
<td>Songda</td>
<td>Medium</td>
<td>Released, 2012</td>
<td>200</td>
</tr>
</tbody>
</table>

Total yield (mt) 2.63

Conclusions/Recommendations:
The release of the three varieties concluded a cycle of breeding activities. Farmers now have the needed technology to manage Striga on cereal fields by a two-year rotation of efficacious trap-crop soybean varieties with Striga-tolerant maize varieties developed under the Drought Tolerant Maize for Africa (DTMA) project, of which SARI is a major player. Breeder and foundation seed of these lines would be produced during the dry season of 2013 for seed companies interested in producing certified seed. Part of the seed will also be used for demonstrations across northern Ghana for wider dissemination by inviting farmers to observe these technologies during farmers’ field days. Factsheets and production guides would also be produced to facilitate the production process by farmers, extension agents and seed companies.

Future activities/The way forward:
The Soybean Improvement Programme would continue varietal development using parental lines selected in a crossing programme in the coming years. With the screen house due for rehabilitation soon, a comprehensive crossing work would be started by June, 2013 to incorporate desirable traits into commercial and breeding lines. Traits of concern include earliness, high yield, resistance to pod-shattering, biological nitrogen fixation, disease and pest resistance/tolerance, drought resistance/tolerance, etc.

Efforts would be made to widen the current gene pool by germplasm introduction from sources other than the International Institute for Tropical Agriculture (IITA). Requests have been made to AGRA for assistance to acquire germplasm from other institutions affiliated to it throughout Africa, particularly from East and Southern Africa. Additional sets of early and medium/late maturity lines will nonetheless continue to be introduced from IITA.