CRAWFORD

SOYBEAN RESEARCH IN UGANDA *

BY

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1. INTRODUCTION.

a) Historical Perspective.

Soybean was introduced in Uganda between 1908 and 1913. However, serious production did not occur until 1940's when, due to a war time demand from Britain, cultivation reached 14,000 - 16,000 hectares. In 1950 Soybean exports reached a record level of 4,314 tons before undergoing a decline after 1952. In 1955, experimental yields of 1,100 kg/ha were obtained using no fertilizers.

As a result of a need for agricultural diversification, import demand in Europe and pressure from human nutritionists, there was renewed interest in Soybean production in 1965. Hence, between 1965 and 1968 annual production increased from less that 1000 tons to 8,000 tons. Between 1981 and 1983 about 5,000 - 6000 hectares of soybean were planted annually with average yields of over 1 ton/ha (Hittle, 1987).

Soybeans are a very important source of food and feed. They are also a source of income for farmers, a source of edible oil and a potential nontraditional export crop. While soybean is processed for animal and poultry feeds in Uganda its use as a source of edible oil is still limited.

b) Research.

Since 1960, research on soybean has been conducted by the Ministry of Agriculture and Makerere University. Accessions and breeding lines from many countries have been received and evaluated. Experimental yields have ranged from 400 - 3,907 kg/ha. By 1975 six varieties namely S - 35, Congo 72, Clark 63, Bukalasa 4, No.7 and Kabanyolo 1 had been released. Information on farm-level performance of each of them is not easily available but Kabanyolo 1 seems to have performed best as it is still cultivated by many farmers.

Due to the civil strife of the last 15 years, soybean varieties, breeding lines and seed increases were lost. Since 1973, many INTSOY trials were conducted. The results of these trials, however, have either not been reported or reports have largely been lost. Only one report, for trials conducted in 1976-77, is currently available. In this report sixteen entries with eight local checks were used and yields ranged from 694 to 1725 kg/ha with a grand mean of 1364 kg/ha. Hence there was evidence as far back as 1977 that imported soybean material could perform well under Uganda conditions (Hittle 1987).

* Report is basically a summary of soybean research in Uganda.

2. CURRENT RESEARCH PROGRAM

a. Objectives.

The program set out to identify the current soybean production and utilization constraints for purposes of setting research priorities. The methodology utilized is not documented.

The following have been identified as Uganda's major soybean production and utilization constraints; lack of improved varieties, declining soil fertility, limited utilization at household level, and poor marketing. The programme has two broad objectives. The first is to select and develop soybean varieties of medium maturity (100 -120 days) which are high yielding; non shattering; resistant to lodging, major pests and diseases; free nodulating; with good pod clearance and which can store well for at least 7 to 8 months. The second is to identify appropriate agronomic practices which will maximize the performance potential of commercial soybean production in Uganda. As per the foregoing discussion, breeding and agronomic constraints were given first priority.

To achieve the above objectives, the following research projects are currently being undertaken; continued germ-plasm collection, characterization/ evaluation and maintenance of promising lines, multi-locational variety trials, variety development through hybridization, mutation breeding, plant population studies, herbicide screening and on-farm research.

b. Breeding.

(i) 1987.

In January 1987, 40 (TGM & TGX series) soybean varieties were received from IITA. In February 1987, 57 cultivars originating from different parts of the world were received from Georgia USA and 6 (TGX series) soybean varieties were received from IITA. In May 1987, eleven soybean varieties from Newton, Georgia, were also received at Kawanda Research Station. In July 1987, 46 breeding lines were received from IITA (TGX and PP series) while 445 more breeding lines and varieties were provided by IITA in August 1987. This material was intended to provide the germ-plasm for the selection and development of soybean varieties suited to Uganda's conditions. Where there was sufficient seed, the seed lots were divided among Kawanda, Namulonge and Bukalasa. In the first season of 1987 the trial at Kawanda was planted late while data from Namulonge and Bukalasa has not been reported.
In the second season of 1987, yield trials were conducted using six varieties from Intsoy international experiments together with two local checks; Kabanyolo 1 and No. 7. The trials were planted at three locations; Mubuku, Kawanda and Bukalasa. The objective was to identify varieties to replace Kabanyolo 1 which is low yielding, shatters and lodges. Yield trials were also conducted at the three locations using eight IITA varieties and two local checks namely: TGX 297-6F, TGX 536-020, TGX 539-5E, TGX 849-294D, TGX 849-313D, TGX 995-22E, TGX 996-25E, TGX 996-28E, and local checks Kabanyolo 1 and No. 7.

468 IITA breeding lines were received and planted at Kawanda and Bukalasa during the second season of 1987 but no data was collected. Generally, results for 1987 trials have not been available.

(ii) 1988.

During the first season of 1988, yield trials were conducted at Namulonge, Mubuku, Bukalasa and Nakabango. Eleven varieties were tested including six from INTSOY, three from IITA and two local checks. These were: ICAL 131, TGX 536-02D, Duocrop, TGX 996-25E, Kabanyolo 1, No. 7, Hartz 9190, ICAL 132, TGX 996-28E, UFV-1 and Jupiter. These varieties were assessed for nodulation, bacterial pustule, virus incidence, lodging, shattering and seed yield. Yields ranged from 1220 kg/ha for Jupiter to 1628 kg/ha for TGX 996-28E. No 7 showed serious bacterial pustule.

At Namulonge, varieties TGX 996-25E, TGX 536-02D, ICAL 131 and Duocrop yielded as well or better than the local check, Kabanyolo 1. The remaining ones yielded lower than the check. In absolute terms ICAL 131, TGX 536-02D and Duocrop yielded better than the rest.

With the exception of TGX 536-02D and Kabanyolo 1 all the other entries gave their highest yield at Bukalasa.

At Mubuku, the three IITA entries namely TGX 996-25E, TGX 536-02D and TGX 996-28E performed best with mean yields of 1873 kg/ha. Kabanyolo 1 performed poorly with a mean yield of 452 kg/ha. The trial at Mubuku had a very high CV thus it was removed from the location interaction analysis. All entries except UFV-1 and Jupiter gave good results. At Nakabango only TGX 996 -25E yielded significantly higher than Kabanyolo 1 with 1676 kg/ha.

The most stable entry across locations which also had the highest average yield was TGX 996-25E from IITA with 1628 kg/ha. However, this variety lodges and is susceptible to virus attack resulting in seed color problems.

ICAL 131 was identified as resistant to bacterial pustule and virus, it doesn't shatter or lodge and was more adopted across location than Kabanyolo 1 in terms of seed yield. It had an average yield of 1524 kg/ha while Kabanyolo 1 had an average of 1388 kg/ha. Other high yielders were either lodging, susceptible to bacterial pustule or shattering. ICAL 131 matures in 120 days but drought resistance was not assessed.

In the second season of 1988 five of the soybean materials received in 1987 from IITA as part of the International trials were tested at Mubuku and Namulonge. These were TGX 995-22E, TGX 297-6F, TGX 539-5E, TGX 849-294D, TGX 849-313D. Kabanyolo 1 and No. 7 were included as local checks. TGX series had a mean yield of 1944 kg/ha while the local checks averaged 1405 kg/ha across the two locations. TGX series were also less shattering but lodged, were late maturing and suffered severe virus infection.

The 1988 trials showed that generally, IITA lines yielded better than INTSOY lines when grown at the same location. This is probably because IITA lines grow over a longer period and nodulate well. They however lodged, were late maturing and suffered severe virus infection.

For yield trials in the second season of 1988, the original 11 varieties used during the first season were reduced to six. These six were:ICAL 132, HARTZ 9190, TGX 536-02D, ICAL 131, Duocrop and Kabanyolo 1 (local check). The trial was located at Namulonge, Nakabango and

Mubuku. The trials at Namulonge and Nakabango were inoculated with a single strain of Bradyrhizobium japonicum TAL 102 from NIFTAL. The Mubuku trial was not inoculated.

Compared to the first season, yields were very good especially at Namulonge and Nakabango averaging 2612 kg/ha and 3140 kg/ha respectively. At Namulonge there were no statistically significant differences in yields between the entries. At Nakabango Duocrop and Hartz 9290 gave similar yields which were significantly higher than the rest of the entries; 3493 kg/ha and 3476 kg/ha respectively. ICAL 131 though not significantly different from TGX 536 - 02D and Kabanyolo 1 yielded better that ICAL 132. At Mubuku, yields of all entries dropped significantly with exception of TGX 536-02D whose yield was consistent across the three locations with a mean of 2889 kg/ha.

During the same season (2nd season, 1988) an international soybean trial was also conducted using eight entries from IITA with two local checks. The trial was located at Namulonge and Mubuku and inoculum was not used. The eight entries were TGX 536-02D, TGX 996-28E, TGX 1019-2E, TGX 849-313D, TGX 849-294D, TGX 996-25E, TGX 984-2E, TGX 849-297D, with Kabanyolo 1 and No. 7 as the local checks.

At Mubuku all the entries except the local checks yielded over 2,000 kg/ha. At Namulonge yields were also good including improved performance of the two local checks. Some lines matured later than 120 days after planting. Virus and lodging scores were also high in some cases rendering the materials un acceptable for release to farmers. The trial was to be repeated in the first season of 1989.

Over 3 seasons of testing (1987 and 1988), varieties ICAL 131, Duocrop, Hartz 9190 and TGX 536 -02D proved to be high yielding. They out yielded Kabanyolo 1 in most cases. However, Duocrop and HARTZ 9190 have a problem as they easily lose viability during storage for periods up to seven months. ICAL 131 was identified as the most stable, disease resistant, non shattering, and non lodging.

(iii) 1989.

In the first season of 1989, eight IITA varieties namely; TGX 536 - 02D, TGX 849-297D, TGX 849-313D, TGX 849-294D, TGX 996-25E, TGX 996-28E, TGX 1019-2E, TGX 984-2E. Three local checks, ICAL 131, Kabanyolo 1 and No. 7 were also evaluated. The trials were planted at Mubuku, Kabanyolo, Namulonge and Nakabango between mid march and early April 1989. Ninety kilograms per hectare of P_2O_5 was applied but inoculum was not applied.

Average yields were highest for TGX 536-02D; 2195 kg/ha followed by ICAL 131; 2046 kg/ha, then TGX 849-297D; 1949 kg/ha. Poor average yields were obtained for No.7, TGX 984-2E and Kabanyolo.

Variations in vigor and seed yield were highest in ICAL 131, Kabanyolo 1, and No. 7. This was probably due to late or poor nodulation as these varieties lack the cow-pea type rhizobia incorporated into IITA materials.

Because of the superiority of ICAL 131 it was proposed to the National variety release committee in August 1989 and was given partial release under the name Nam 1.

The 468 IITA breeding lines that had been planted at Kawanda and Bukalasa in 1987 were again planted at Namulonge during the first seasons of 1988 and 1989. Due to lack of any appreciable within line variability, 8 lines were selected at the end of the first season of 1989. These were: 87D-25, 87D-668, TGX 536-02D, 87D-434, 87D-2450, 87D-2096, 87D-2097, 87D-1303. Yields ranged from 2310 kg/ha for 87D-1303 to 1803 kg/ha for 87D-2097.

The varieties were selected on the basis of nodulation, lodging, bacterial pustule, virus and seed yield assessment scores. They were to be planted at Namulonge in the second season of 1989.

During the first season of 1989, crosses were also made using ICAL 131 (INTSOY), TGX 849-294D (IITA), TGX 1019-2E (IITA), TGX 539-5E (IITA), Kabanyolo 1 (local), TGX 996-25E (IITA), TGX 996-28E (IITA) and Hartz 9190 (INTSOY) as parents. The F1 were to be grown as spaced plants in second season 1989.

Bulks and seed increases of ICAL 131 and Kabanyolo 1 were also conducted in the first season of 1989 to obtain seed for the Uganda seed project and for on-farm research.

In the second season of 1989, variety trials were conducted at Namulonge, Nakabango and Ikulwe. Varieties Kabanyolo 1, ICAL 131 and No. 7 were used as local checks. The trials were conducted at preliminary and uniform stages.

The preliminary stage comprised of nine varieties and two local checks and was planted at the three locations. A soybean international observation trial was also planted at Namulonge and Ikulwe comprising of 13 entries from IITA and two local checks.

The season was generally very wet all the way up to harvest time and this led to reduced seed quality of some of the materials harvested. Duiker variety was most hit and it succumbed to purple stain (Cercospora kikuchii).

Entries in the preliminary variety trial were 177, 367, 201, 223, 366, 73, 310, 30, ICAL 131, 389 and Kabanyolo 1. Most performed very well except line 389 and Kabanyolo 1 which yielded less than 2 tons/ha. Line 177 was the best yielder followed by lines 367, 201, and 223. The two controls were among the three lowest yielders.

Entries in the uniform stage trial included TGX 10192E, TGX 536-02D, TGX 849-294D, TGX 849-313D, TGX 996-28E, TGX 849-2970D, Kabanyolo 1, No. 7, ICAL 131, and Duiker. Variety TGX 849-313D gave best yields at both Namulonge and Nakabango. At Ikulwe the best yielder was TGX 849-394D which was second best at Namulonge. The best yielders had yields ranging from 2.2-2.6 mt/hectare.

For the international observation trial; at Namulonge ICAL 131 was highest yielder followed by Kabanyolo 1. then TGX 1213-1D. At Ikulwe ICAL 131 yielded best followed by TGX 1213-1D. Over the three locations ICAL 131 maintained a reasonable yield. Entries TGX 536-02D, TGX 849-294D, TGX 849-297D, TGX 996-28E, and TGX 849-313D were kept on a stock of elite materials in the germ-plasm collection.

Also in the second season of 1989, 11 F1 crosses from first season crosses were planted (results not reported) and sixteen more new crosses were made during the season. Seed bulking

continued with two hectares of ICAL 131 planted to assess uniformity and raise seed for the seed project and for on-farm research. The performance was reported as satisfactory.

(iv) 1990.

In the first season of 1990, variety trials were conducted at Namulonge, Nakabango and Ikulwe. These were at three stages namely; preliminary, uniform and advanced.

Preliminary and advanced trials had 11 entries each while the uniform trial had 10 entries. The preliminary trial was planted only at Namulonge. In all trials Kabanyolo 1 and Nam 1 (ICAL 131) were used as local checks. Entries in the preliminary trial included 9 breeding lines selected out of the 468 lines from IITA plus Nam 1 (ICAL 131) and Kabanyolo 1 as local checks. The 9 IITA lines were 223, 30, 367, 201, 366, 177, 310, 389, and 73. Lines 223 and 30 gave yields of over 3 tons/ha. Lines 233 is, however, black seeded and not preferred by farmers and consumers in Uganda.

The local checks yielded significantly higher than 3 IITA lines and less than two IITA lines in the trial.

The uniform variety trial comprised of TGX 1019-2e, TGX 536-020, TGX 849-297D, TGX 849-313D, TGX 996-28E, TGX 849-294D, Kabanyolo 1, No. 7, Nam 1 (ICAL 131) and Duiker. Yields were best at Namulonge with all entries (except TGX 870-610) yielding over 2 tons/ha. Variety TGX 536-020 gave highest yield of over 3 tons/ha. Only two varieties; TGX 536-02D and TGX 1073-44E yielded better than the local check Nam 1 (ICAL 131) which maintained stable yields. Yields were poor at Nakabango and Ikulwe. Results of the advanced trial were not reported.

Over the three locations Nam 1 (ICAL 131) maintained stable yields. Other lines considered as candidates for new varieties include TGX 536-02D, TGX 1019-2E, and TGX 849-297D with a record of stable performance.

Though most high yielders are black seeded they will be used as breeding material.

During this season also F1s from the 16 crosses of the previous season were harvested as single plants. Segregating F2 progenies were also grown and single pods picked to advance the progeny to F3. Work also continued on germ-plasm characterization, evaluation and maintenance. Seed bulking also continued with Nam 1 (ICAL 131) and Kabanyolo 1 at Namulonge. The purpose was to assess uniformity and produce seed for the seed project and for on-farm research.

In the second season of 1990, variety trials continued at Namulonge, Nakabango and Ikulwe. These were also at three stages namely: uniform, advanced, and international trials. The international observation trial had 15 entries. The uniform trial was conducted at all the three locations. Advanced and international trials were conducted only at Namulonge. In all cases Kabanyolo 1 and Nam 1 (ICAL 131) were included as local checks.

The entries in the uniform variety trial were 870-610, 870-1174, 870-2478, TGX 536-02D, TGX 1073-44, TGX 1158-4D, TGX 1213-1D, TGX 1293-1D, TGX 12932D, Kabanyolo 1 and Nam 1.

At Namulonge most entries yielded over 2 tons/ha. Yields at Ikulwe ranged from 1.3-2.6 tons/ha. Even the highest yield at Nakabango was less than 2 tons/ha.

The two local checks Nam 1 and Kabanyolo 1 were among the first three best yielders at Namulonge and Nakabango. They were however among the last yielders at Ikulwe.

Across the locations TGX 1073-44E was the highest yielding and Nam 1 and Kabanyolo 1 did well at these location except Ikulwe. TGX 1073-44E was to be evaluated further for possible inclusion into the elite materials. During this season it was also decided that more than four variety trial centers off the station be used to subject materials to a wider range of environments.

Entries into the advanced variety trial were 223, Nam 1, Kabanyolo 1, 366, 310, 367, 30, 177, 201, 72 and 389. While they all performed well, line 223, gave the best yield followed by the two local checks. Line 223 was identified for use in the hybridization work in the first season of 1991.

For the international trial, the entries were: TGX 1440-3E, TGX 1448-1E, Nam 1, Kabanyolo 1, TGX 923-2E, TGX 1445-3E, TGX 1447-2D, TGX 849-313D, TGX 1458-2E, TGX 536-02D, TGX 1455-2E, TGX 1447-3D, TGX 1485-1D, TGX 1437-1D, and TGX 1497-1D. Performance was good ranging from 1.2-2.6 tons/ha. Only two varieties performed better than the local checks in terms of yield. These were TGX 1440-1E and TGX 1448-1E. All IITA materials matured later than the two local checks.

Work continued on variety development by growing F2 and F3 progenies. Single pods were picked from each plant to advance the progenies to F3s and F4s respectively.

With germ-plasm characterization, work had started on regenerating the 468 IITA breeding lines and assessing eleven varieties from the Asian vegetable research and development center and eight varieties from the USA. Due to insufficient soil moisture, germination was very poor and the work was to be repeated in the first season of 1991.

During this season work was also initiated on mutation breeding. Materials of Nam 1 and Duiker were irradiated in Vienna in June 1990. Treated materials were planted with untreated ones and were found to be late to emerge by three days. They also reached physiological maturity 15 days later than untreated ones.

Single plant selections of irradiated materials were made and bulked to be advanced to the second (F2) generation in the first season of 1991.

Work also continued with the seed bulking of Nam 1 and Kabanyolo 1 varieties. Plots of these were assessed for uniformity while seed was given to the Uganda seed project and the on-farm research programme.

(v) 1991.

In the first season of 1991, a variety trial was conducted at advanced and uniform stages. The uniform trial was conducted at four locations; Namulonge, Nakabango,Ikulwe and Masindi

while the advanced trial was only at Namulonge. Ten entries namely; TGX1019-2E, TGX536-02D, TGX1073-44E, TGX849-297D, L30, L73, L310, Duicker, Kabanyolo 1 and Nam 1 were used.

Over the four locations, yields ranged from 1.5-2.7 mt/ha. TGX536-02D had the highest average yield of 2726 kg/ha while Duicker had the lowest average yield of 1548 kg/ha (Soybean program progress report 1991). At Namulonge Rhizobium japonicum and phosphorus fertilizer were used. This probably makes comparison with other locations difficult since treatments were not the same.

The advanced trial at Namulonge comprised of 11 entries namely;
TGX1455-2E, TGX1440-1E, TGX1437-1D, TGX1458-2E, 177, 201, 223, 367, 389, Kabanyolo 1 and Nam 1. Yields ranged from 2.3-3.6 mt/ha. The highest yielder was TGX1440-1E while the lowest yielder was TGX1437-1D.

Also in this season,segregating populations at F_3 and F_4 of previous years were planted. F_3 were advanced to next generation by single pod selection, F_4 were advanced by both single pod and single plant selections.

In the second season, 10 entries were used in the uniform trial;
TGX1019-2E, TGX1455-2E, TGX1073-44E, TGX849-297D, L30, L73, L310, TGX1440-1E, Kabanyolo 1 and Nam 1. Three locations were used namely; Namulonge, Masindi and Kasese. Average yields across the 3 locations ranged from 1.1-1.4 mt/ha. Nam 1 was the best yielder while L30 had the lowest yield. Variety L73 with average yield of 1214 kg/ha is being considered for release to be grown along with Nam 1 and Kabanyolo 1.

The second season advanced trial also comprised of 11 entries namely; TGX1437-1D, TGX1458-2E, 177, 201, 223, 367, 389, Kabanyolo 1, Nam 1, TGX1019-2E and K-Loc.

This trial was also located at Namulonge. Yields ranged from 0.6-1.5 mt/ha. The highest yielders L223 and TGX1458-2E are black seeded,late maturing and could not be advanced to the uniform trial.

In this season more single plants were selected at F_4 stage and over 400 populations were advanced to F_5 and F_6 stages.

In 1991 germplasm regeneration and characterization activities were also conducted. 469 lines were received from IITA, AVDRC-Taiwan, USA, Zimbabwe and 36 collected locally. Fifty six collections were also evaluated using the already mentioned evaluation criteria.

c. Agronomy

i) Planting date and Population trials

Planting date trials were initiated in the first season of 1988 at Namulonge, Kamenyamigo and Kisindi to determine the appropriate planting time for soybean seed. The trial at Kisindi was discarded due to a heavy attack by the green stink bug. Six different planting dates were evaluated. The first two planting date treatments ranging from February 10th-25th gave the

highest yields and seed quality. Yields were 1486 kg/ha for February 10-13 and 1648 kg/ha for February 22-25.

Six planting dates were evaluated at Namulonge in the second season of 1988 and phosphorus fertilizer was used at planting. Early planted soybean yielded better with the highest yield per plant occurring in early planted treatments; August 11-13 yields were 1823 kg/ha, August 21-23 yields were 1683 kg/ha while August 31-September 2 had yields of 1754 kg/ha. October planted soybean varieties had lowest yield of 292 kg/ha.

ii) Spacing trials

Spacing trials were conducted in the first season of 1988 to establish optimum spacing for soybean. The trials were planted at Mubuku, Kabanyolo and Namulonge using Kabanyolo 1 variety. Spacing of 40x 5cm, 50x5cm, 60x5cm, 70x5cm, and 30x5cm were evaluated. Yield data for Kabanyolo and Mubuku showed no significant differences between the spacings. For Namulonge while there were no significant differences between the first four spacing, the 70x5cm treatment significantly reduced yield.

A row spacing trial was also conducted in the second season of 1988 at Namulonge, Kabanyolo, and Mubuku using Kabanyolo 1 variety. The objective was to determine the optimum row spacing for optimum yield in soybean. Four different "between row" spacing namely; 40cm, 50cm, 60cm, 70cm were used. No significant yield differences were obtained at any of the three locations but yields at Kabanyolo were much better.

These trials were followed up by further work in the first season of 1990. The objectives of the 1990 trials were to determine the optimum plant populations attainable using a hand hoe, to asses grain yield at various plant populations and spacings and to assess the advantages and disadvantages of different spacings.

Earlier work (1987) had recommended a spacing of 60x5cm for soybean and a seed rate of 30 kg/ha. However, it was found that this was very difficult to achieve without planters or seeders. Hence this work aimed at finding alternative spacing and plant population recommendations.

Nam 1 variety was used and the spacing treatments included 100 x 25cm (2 plants/hill) with a density of 121,503 plants/hectare, 30 x 30cm (2 plants/hill) achieving 333,000 plants per hectare. The experiment was located at Namulonge and Ikulwe. A replication in space was also planted at a very wide spacing of 60 x 60 cm, 1 plant per hill with a density of 27,777 plants per hectare. The purpose was to obtain information on the branching and podding ability of soybean. At Ikulwe, the treatments were not significantly different from each other but at Namulonge significant yield differences were obtained. While there were no significant differences between the 60 x 5cm and 30 x 30cm spacings, both treatments yielded significantly higher than the 100 x 25cm spacing.

Nam 1 was verified as having the capacity to put on more branches, leaves and pods at lower densities to compensate for available space. A negative correlation between population density and number of branches and pods/plant was confirmed. Maximum podding and branching was exhibited by the space treatment with an average of 9 branches and 176 pods per plant. Least

branching and podding was exhibited by the 60 x 5cm spacing treatment with an average of 3 branches and 31 pods per plant.

In the first season of 1991, more soybean spacing trials were located at Namulonge, Nakabango, Ikulwe and Masindi. The objective was to establish a hand planted spacing and associated advantages using Nam 1. Treatments were 75x15cm 2 plants/hill, 30x30cm 2 plants/hill, 50x25cm 3 plants/hill and 60x5cm 1 plant/hill. Significant differences were observed only at Namulonge. The 30x30cm and 50x25cm treatments gave significantly higher yields than the 60x5cm treatment. The 50x25cm treatment was found easiest and economic regarding time and labor and was recommended for the hand hoe while 60x5cm was recommended for planters.

Also during this season, pre and post emergence herbicide screening trials were set up using Nam 1. Entries for the pre-emergence were Scepter (1.2 l/ha), Pursuit plus (1.2 l/ha), Pursuit (250mls/ha), Panter (5 l/ha), hand weeding and unweeded control. In terms of grain yield, Pursuit, Pursuit plus and Scepter treatments gave yields as good as hand weeding which were significantly higher than yields obtained with Panter. Results were pronounced as inconclusive and further investigations recommended. Noteworthy is that the control gave yields of 2.3 mt/ha; very close to herbicide treatment yields.

Entries for the post emergence were Basagran; 3l/ha + Focus 2l/ha, Galaxy 3 l/ha + Focus 2l/ha, hand weeding and unweeded control. The trial was located at Namulonge using Nam 1. Basagran + Focus treatment gave yields as good as hand weeding. No significant difference was found between Basagran+Focus and Galaxy + Focus treatments though the later was reported as giving consistently lower yields. These results were regarded as confirmatory to earlier findings hence Basagran 3 l/ha + Focus 2 l/ha applied with a 4-7 days interval was recommended for broad and narrow leafed weeds control in soybean.

In the second season of 1991, new pre-emergence herbicides namely; Command and Pillarsett were screened at Namulonge, Nakabango and Ikulwe using Nam 1. Treatments were Command 2 l/ha, Pillarsett 2 l/ha, hand weeding and unweeded control. Both chemicals did not affect soybean germination. Command did better than Pillarsett at Namulonge but performed just as well at Ikulwe and Nakabango. Weed biomass analysis showed that Command had a higher weed suppressing effect than Pillarsett at Nakabango but not at Ikulwe and Namulonge. At both Nakabango and Ikulwe hand weeding gave significantly higher yields than both Pillarsett and Command. The two chemicals were found ineffective on rhizomes and deteriorated after 4 weeks. More research was recommended. In this trial the unweeded control gave significantly higher yields than the other three treatments. This is important and points to the need for a cost-benefit assessment before making a recommendation.

iii) Inoculation trials

Rhizobium inoculation trials were conducted in the second season of 1988 at Namulonge and Nakabango. Duocrop, Kabanyolo 1, and Hartz 9190 were used as test crops and the inoculant used was a single strain of Bradyrhizobium japonicum TAL 102 obtained from NifTAL. There was a good yield advantage resulting from inoculation at both sites. Differences between inoculation treatments were significant at Namulonge but not at Nakabango (see Table 1. below).

Table 1. Yield Differences (kg/ha) between Inoculated and Non-inoculated Soybean Varieties, 2nd Season 1988.

LOCATION	VARIETY					
	Duocrop		Kabanyolo 1		Hart 9190	
	Inoc	Not-Inoc	Inoc	Not-Inoc	Inoc	Not-Inoc
Namulonge	2546	1921	3379	2257	3347	2712
Nakabango	1721	1546	1827	1645	1632	1289
Mean	2134	1734	2603	1951	2490	2001
Mean Difference	400		652		489	

Source: 1988 Research Report on Maize, Soybean and Sunflower Field Trials. Ministry of Agriculture, USAID/MFAD Project, pp 41.

The small differences at Nakabango could have resulted from a drought. The trial was to be repeated in the first season of 1989.

iv) Herbicide trials

The objectives of this work initiated in the second season of 1989 were to determine the optimum application rates for Basagran and Focus under Ugandan conditions and to establish the tolerance level of soybean to these herbicides.

A combination of Basagran and Focus was screened as most suitable for weed control in soybean and secondary screening of this combination was continued in the first season of 1990. This experiment too was located at Namulonge and Ikulwe. Six treatments were used namely; R0, R1, R2, R3, R4, and R5.

R0 was a control and received no herbicide, R1 was the recommended rates of Basagran (3 liters/ha) and Focus (2 liters/ha). R2 was twice, R3 thrice, R4 four times and R5 five times the recommended rates.

At Namulonge good results were obtained and soybean was found to be tolerant to the two chemicals even at very high concentrations. Overall weed control was found to be similar at all rates though higher rates achieved quicker results. Grain yield analysis revealed no significant differences between the treatments.

The experiment confirmed that the lower herbicide rate of 3 liters/ha and 2 liters/ha of Basagran and Focus respectively are more economical than higher rates. It was also established that one week should be allowed between the two applications avoiding tank mixtures. Best results were achieved when weeds were at the 2 - 4 leaf stage.

3. ON-FARM RESEARCH

Soybean on-farm trials have been conducted since the first season of 1988. In 1988, three districts were involved namely; Masaka, Luwero and Masindi. Masaka was dropped in the second season of 1988 and in this season Kasese trials were not harvested reportedly because of drought. Mubende and Mbale districts were included in the first season of 1989 and first season of 1991 respectively. Until the end of 1989 Kabanyolo 1 variety was used and Nam 1 has been used since the first season of 1990.

The treatments used have varied in different seasons but generally include;Farmers method of planting,Line planting, Line planting with 150kg/ha of TSP fertilizer,Line planting with 100kg/ha of TSP fertilizer,Line planting with 150kg/ha TSP fertilizer+Rhizobium and Line planting with 100kg/ha TSP fertilizer+Rhizobium. The treatments and average yield results are presented in Table 2 below. Note that higher yield levels have been obtained with higher levels of phosphorus and inoculation.

Beginning January 1993 the soybean program is to embark on an integrated soybean project aimed at promoting soybean production and utilization. It will be implemented by researchers and home economists. Other institutions such as Makerere University, IITA, INTSOY and others will be involved. It will cover the Eastern and Northern parts of Uganda. The project will include; documentation of the current status of soybean utilization, extension training, production and utilization demonstrations, technology introduction and information dissemination. It is estimated to cost 150,000 US dollars.

4. ACHIEVEMENTS.

The achievements of the soybean research programme include; the release of ICAL 131 as a new variety called NAM 1., the generation of breeding populations and identification of five elite soybean materials. On-farm research has confirmed that a spacing of 60 x 5cm giving 330,000 plants/ha gives optimal yield. It has also been confirmed that phosphorus is basic for soybean production and should be applied at rates of 100 kg TSP per ha or 200 kg SSP/ha. Response to inoculation with Bradyrhizobium japonicum has also been well documented.

5. COLLABORATION AND FUTURE WORK.

The programme collaborates with IITA in joint international soybean variety observation trials, germ-plasm exchange, training and publications.

Future work will focus on development of improved varieties, incorporation of virus resistance, identification of suitable intercrops and crop rotations, as well as soil fertility, inoculation, and soybean utilization studies.

6. INTEREST GROUPS.

Organisations and/or groups interested in soybeans include the Produce Marketing Board (PMB) which purchases for export, Uganda Feed mills which purchase for feed production, and

oil mills for edible oil production. District prison farms also grow soybean for their cattle feed mixes.

7. GENERAL CONCLUSION.

Much has been achieved as far as the original program objectives are concerned. A new variety, Nam 1, was fully released in October 1991 and rigorous selection and breeding activities are going on. Current socio-economic studies on oil crops in general indicate marketing and household level utilization constraints are being carried out. Soybean has a great potential in food and feed usage and the edible oil industry. This seems to be the time to embark on rigorous socio-economic studies on soybean growing at farm level.

Problems limiting soybean marketing and utilization need to be well understood and addressed. Therefore the proposed project mentioned above is timely.

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