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THE PEARL MILLET IMPROVEMENT PROGRAM IN SENEGAL

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ICRISAT / ISRA COOPERATIVE PEARL MILLET IMPROVEMENT PROGRAM IN SENEGAL (1977-1985)

In Senegal, pearl millet and sorghum (0.97 mn ha) are second in importance to groundnut (1.05 mn ha), both in terms of surface area covered and production. Among the cereals, pearl millet is the predominant crop in the north and central regions of the country where rainfall is low and erratic. In the south, where rains are comparatively favorable, the principle crops are sorghum, maize and rice. Over 85% of pearl millet grown is of early maturing type (75 to 90 days to maturity) commonly known as "Souna millet" and the rest is Sanio (120-150 days). Souna is grown in the north and central regions of the country and extending towards sourthern part of the country replacing Sanio.

The major problems in pearl millet production are low grain yield, paor harvest index, diseases mainly downy mildew, smut, and sometimes ergot, insects mainly Raghuva sp., drought at anytime, and occasionally Striga. The indirect problem is the continuous degradation of the soil fertility year after year. This could be becausè of several reasons but one of the most important is plant type-very tall with poor harvest index. The rapid progruss in genet ic improvement is possible because of the wide range of ganetic variability available in germplasm and the ease of crossing utilizing the protogynous nature of the crop.

1. BACKGROUND OF PREVIOUS RESEARCH

The millet improvement program at 'Centre National de Recherches Agronomiques (CNRA)', Bambey started as early as 1931 by producing inbred lines by pedigree selection in two local populations. By 1949, CNRA developed 113 lines of millet. Through selfing, the lines lost the vigor of the populations. The variety 165 gave 20% more grain yield than the lines derived from this population. Twenty-eight selections were made by 1959 based on yield per plant and other characters associated with yield per plant. These were tested between 1959 and 1961. There was an improvement in homogeneity but the yield levels were not better than the farmers local. In 1961, recurrent selection work (simple and reciprocal) was started on early and late populations (Etasse, 1965).

Bono and Leclercq (1963) suggested that the pedigree selection can not be directly used as it only allows the establishment of a reserve of interesting inhred lines. Moreover, complex mass selection is efficiené on local unimproved populations. This method allows improvement up to 30%. The hybrids obtained by cross breeding between a population and an inbred line have given up to 147% of the local population as best results, Favorable results have been obtained by mixed cultivation of several varieties in the same seed hill.

In 1965, three recurrent selection programs on Souna millets and two on Sanio millets were in progress. The three recurrent selections on early millet were grouped into a single synthetic Souna 2. This synthetic was 107 and 121% superior to local check in first and second generation of multiplications, respectively. The synthetics obtained from selection on late varieties gave interesting resul ts only in first generation of multiplication. Souna 2 was improved through top cross testing using PC 28 (Souna of Bambey Serere, Senegal) as a tester and then Souna 2 itself as a tester (Etasse, 1969). Eight lines (106-7, 108-4,113-3, 115-4, 134-5, 142-4, 143-4 and 148-3) were extracted from Souna 2 through top cross testing were recombined in 1969 to form Souna 3. This variety was released for general cultivation in 1972.

In 1970, Senegal launched a multidisciplinary (genetics, physiology, pathology, entomology and agronomy) program on millet improvement out of a determination to achieve self-sufficiency in food through diversification. The main selection criteria was the improvement in harvest index . This was achieved by crossing 29 African populations (8 from Burkina Faso, 6 from Mali, 10 from Niger, 4 from Senegal and 1 from Chad) with three dwarf parents (23 D2 5 and 239 D_2 B from USA and I 472 from India).

In 1973, the synthetic GAM 73 was developed by recombining the morphological similar progenies derived from a cross I 472 x HK 1133. The characteristics of GAM 73 were dwarf plant height (135 cm,), longer ear head (144.5 cm.), few effective tillers per plant (2.9) and high harvest index (41%). By the middle of 1974, another synthetic GAM 75 of completely different plant type was developed by recombining morphologically similar 15 F_4 progenies derived from a cross Tift 23 D2 B x Aniata. Heads were more in number but much shorter of GAM 75 than GAM 73, to facilitate threshing with

machines. Stems of GAM 75 were much more thinner than those of plants constituting the population GAM 73, resulting in reduced efforts for the cutting of stems and ploughing at harvest (Bilquez, 1974). These two synthetics gave good results under irrigated and highly fertilized soils but could not compete with traditional varieties under farmer's situation. These synthetics also had poor threshing percentage (55%) as compared to other millet varieties (70%).

Agroclimatic research by CNRA has shown that the millet having a vegetative cycle of 90 days can be grown with at least an 80% chance of success each year in the region of Bambey-latitude 14°30' N, average rainfall 648 mm. The chance of success becomes 42% when grown further north in the region of Louga (latitude 15°30' N, average rainfall 481 mm) and only 26% in the region of Podor (latitude 16°30'N, average rainfall 333 mm), In order to have 80% of success each year, millet grown in the region of Louga must not have a vegetative cycle exceeding 75 days and for those grown in the region of Podor, a vegetative cycle not exceeding 60 days (Dancette, 1974).

Based on above recommendations, attempts were made to produce 60, 75 and 90 days synthetics for different regions of the country, Based on combining ability tests, the parents were chosen from existing material for creating the synthetics of different maturity cycles. Only a few parents could be selected to form one of the each 60 and 75 days synthetics and several fines were identified with 90 days maturity type to form seven 90 days synthetics. The different generations of random mating of two early maturing dwarf synthetics (60 and 75 days) were compared with Souna 3 (a tall 90 days synthetic) during 1977 to 1979. Early maturing synthetics could not produce equal yield as compared to Souna 3 even in the environments for which they were developed (C. Lambert, 1980, persona1 communication). This could be because of lack of sufficient lines/materials for the production of 60 and 75 days synthetics,

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) was constituted by the Consultative Group on International Agricultural Research (CGIAR) in 1972 with a view to improving the yields and quality of five principal crops, sorghum, millets, chick-peas, pigeon-peas and groundnuts in the semi-arid tropics which cover a wide belt of Asia, Africa, Latin America and Australia. These crops are grown in a harsh environment-deple ted soils, erratic rainfall and sparse or no irrigation-by small farmers

wittr very limited resources. ICRISAT has a special mandate for reserach in farming systems, socio-economic constraints and transfer of technolagy for the seasonal ly dry semi-arid tropics to catalyze a break- thsough in the agricultural production of the region. In Senegal, ICRISAT, in collaboration with Institut Senegalais de Recherches Agricoles (ISRA), started its millet improvement program in 1977 funded by UNDP, with a prime objective of strengthening the national program mainly through diversifying the genetic base. Our emphasis has been to develop new genotypes that combine sources of stress resistance and high yield potential. Efforts are being made to develop interdisciplinary problem-oriented projects in collaboration with scientists in national program such as breeder, pathologist, physiologist, soil chemist, agronomist and entomologist.

2. OBJECTIVES

a) To diversify the genetic base by introducing new genetic material and by prospecting locally.
b) Breeding for high yield.
c) To improve selected open-pollinated varieties for grain yïeld production, its stability, grain size, harvest index, head length and resistance to diseases.
d) Breeding for pest and disease resistance.
e) Breeding for drought resistance.
f) To develop cultural practices for optimizing grain yield production of newly developed varieties.

3. METHODOLOGY AND EXPERIMENTATION

3.1 Introductions and Local Collections

Since 1977, several pearl millet genotypes were introduced in Senegal mainly in form of regional and internaitonal trials and nurseries (Table 1). Initially, large introductions were made from the ICRISAT gene bank, India, and then from several African countries and recently some from USA. These entries were evaluated for their per se performance under the ecological conditions of Senegal and subsequently recombined the best with the selected Senegalese improved materials in order to take advantage of the genetic distance between these two types of materials. Selected introductions were

also evaluated for their combining ability and few entries were selected to form the synthetic varieties. Soon it was realized that it is necessary to use more of local germplasm in crossing program. The germplasm lines from Senegaf, collec ted by ORSTOM in 1976 and maintained at ICRISAT, were transferred and evaluated in 1981 rainy season. These collections were mainly of Sanio types (late and photosensitive) and new collections were made by us during October/November 1981 from farmer's fields. These collections do not represent the entire collection from Senegal, but a group of diverse millet genotypes gown in different millet growing regions of Senegal. These were evaluated in replicated yield tria1 during rainy season 1982 and the selected lines were used in crosses with selected introudctions,

3.2 Breeding for High Yield

This could be subdivided into three major activities:

-Development of inbred lines.

-Production of synthetics.

-Production of hybrids (less emphasis).

3.2.1. Development of inbreds. The crosses were made between selected GAM (Millet Improvement Team) materials including local germplasm and the selected introductions. The GAM material was d_2 dwarf, susceptible to downy mildew with poor seed setting and the local germplasm lines were well adapted with long heads but very tall and susceptible to diseases. The desirable traits in introduced material were earliness, high tillering, bold grain, medium tall plant height and resistance to diseases and pests. The crosses were made between these two groups during 1977, 1980, and 1981 depending upon the availability of the genetic material. Few crosses were made within each group also to generate new variability and to develop synthetics.

During 1977-78, F_1 hybrids were produced between GAM and ICRISAT material (as GAM x Indian). These F_1 hybrids were advanced by selfing. Several F_1 populations were backcrossed to GAM parent and then advanced by selfing. At the end of pedigree selection, the selected progenies and the introductions were utilized to form synthetics and 54 inbreds possessing many important characters were retained for further utilization. (ICMI 80001 SN to 80054). During 1980-81 off-season, 51 selected entries (including introductions in 1980 and the selected inbreds from above program) were crossed in three

groups: Eleven ta11 entries diallel; 10 dwarf entries diallel and 27 entries were crossed with 3 testers (3/4 Ex Bornu, Souna 3 and IBV 80043 wi th the objective of developing new synthetics and for creating new inbred lines. Fl crosses were evaluated in 1981 in three yield trials. The selec ted entries, based on combining ability, were used to form synthetics, Two hundred ten F_2 populations were grown during rainy season 1982. Three hundred sixty-nine F_3 plants were selected for generation advance in off-season 1982-83, Three hundred and eight F4 progenies were grown in three locations during rainy çeason 1983. Based on multilocational tests, the progenies were selected to form synthetics and hybrids, Fifty-three F_4 derived F_5 progenies were retained for further utilisation (ICMI 84001 SN to 84053).

During 1980, large number of regional and international trials and nurseries were planted in Senegal and the best looking plants were selfed. Eight hundred and eighty-two S2 progenies derived from these were planted at Bambey and Nioro during 1981 for screening against downy mildew and smut. Thirty-three progenies of diverse origin based on maturity, plant height, and bristleness were selected to use in crossing program. These 33 non-Senegalese entries were crossed with 62 Senegalese entries (including 50 local land races) during the of f-season 198 l-82. Seventeen hundred and nineteen F_1 hybrids were evaluated during rainy season 1982 and 240 were selected for pedigree selection. These F_2 pop ulations were grown at two locations-Nioro and Bambey during rainy season 1983 and 30 F_2 were selected for retestiog in 1984, During 1983 individual plants from 182 F_2 populations were selected and advanced to F_5. From this material 94 F_4 derived F_5 and 200 F4 progenies were evaluated for their per se performance during rainy season 1984. Eighty-one F_4 progenies (of 94 F_5) were selected and utilized to generate seven synthetics.

During 1984, all the inbreds/partial inbreds generated by ua in Senegal were evaluated for their per se performance. Fifty-four progenies generated from GAM x Indian crosses are numbered as ICMI 80001 SM to ICMI 80054 SN. These 54 F_6 progenies along with two checks were evaluated in single rows of 6.3 m long with four replications at Nioro and Bambey. Fifty-three progenies (ICMI 84001 SN to 84053) and 94 F_4 derived F_5 progenies (ICMI 84054 SN to 84147) were evaluated at Nioro and Bambey locations in single rows and with three to four replications. Two hundred F_4 progenies (ICMI 84148 SN to 84347)

were evaluated at three locations (Nioro, Bambey, and Louga) in single rows Total 401 inbreds/partial inbreds along with checks in each trial were evaluated during rainy season 1984 for their performance,

3.2.2. Production of synthetics. The component lines for forming synthetics were selected mostly on the basis of per se performance and sometimes based on general combining ability effects coupled with their mean performance.

The generated material until 1979, along with the best introduced material, was utilized to form five synthetics.

-IBV 8001 was synthesized by recombining the three best general combining entries (700516 from Nigeria, Serere 2A and Cassady from Uganda) identified by following diallel cross analysis.

-IBV 8002 was synthesized by recombining the selected 10 F_2 populations derived from GAM x Indian crosses,

-IBV 8003 was synthesized by recombining the dwarf five best general combining entries which were identified following top cross analysis.

-IBV 8004 was constituted by recombining four tall best general combining entries (Souna 3 , 700516, Serere 2A and Serere 14) which were identified following top cross analysis.

-IBV 781.5 was synthesized by recombining the best 13 F_3 progenies derived from GAM x Indian crosses.

These five synthetics, one experimental variety D_2-BB78 developed at Bambey , eight entries introduced from ICRISAT Center, India, and two local checks (Souna 3 and 3/4 Ex Bornu) were evaluated in a replicated yield trial (Senegal Regional Trial) at three locations (Nioro, Bambey, and Louga) during rainy season 1980.

A joint trial was initiated in 1981 to evaluate the selected materials developed by ICRISAT and GAM programs. This trial consisted of six replications of 12 entries-five progeny varieties from GAM (PS90-2, H7-66, H9-127, H24-38, and H4-24), five synthetics from ICRISAT (IBV 8001, IBV 8004, IBV 7815, ICMS 7819 and D_2-BB78), and two local checks-Souna 3 and farmers local. During 1982, three entries (H4-24, IBV 7815, and D_2-BB78) were dropped due to poor performance and a new entry 3/4 HK-B78(M) C_2 (later named IBMV 8401) was included. This trial was conducted from 1981 to 1984 at four locations (Nioro, Darou, Bambey, and Louga) to find out the

high yielding and stable varieties for different regions of Senegal.

Twelve synthetics were generated during 1983-84 off-season. The constituent lines were selected on the basis of per se performance. The synthetics were formed based on maturity, plant height and bristleness. Six F_2 populations-SNS 27, 60, 90, 104, 121 and 145 wera advanced through sibbing during off-season 1983-84. These 18 entries along with two checks were evaluated during rainy season 1984 at Nioro and Bambey locations in a replicated yield trial.

3.2.3. Production of hybrids. A small project was initiated in 1982 to produce variety cross hybrids (Variety x line) to evaluate the hybrid potential. Eight variety cross hybrids were evaluated during rainy season 1982. The results of variety x line cross were not encouraging and this activity was discontinued.

Several single cross hybrids were generated be tween selected inbreds/partial inbreds generated at Bambey and the male-sterile lines developed at ICRISAT Center, India. These hybrids were first evaluated in observation nurseries. The selected hybrids were evaluated in yield trials. A tria1 of 30 entries including two checks replicated five times was conducted at Bambey during 1983. The selected hybrids from above tria1 and the observation nursery were evaluated dur ing 1984 at Nioro and Bambey locations. The tria1 consisted of 25 entries including one check and replic:ated six times. The selected hybrids are being evaluated along with the selected synthetics in multilocational trials.

3.3. Improvement of Open-Pollinated Varieties

This project was started in 1981 with the aim of improving two synthetics, Souna 3 and IBV 8004, through recurrent selection. Though Souna 3 was one of the best and the only released variety in Senegal, it was quite susceptible to downy mildew and possessed variation for several traits like stem thickness and seed size. Souna 3 was also having shibras (*P. americanum* x *P. violaceum*), plants with thin stems, thin heads and vcry small seeds. IBV 8004 was phenotypically variable because of its diverse parental constitution and required improvement in uniformity and head length. Our approach has been t o improve these synthetics simultaneously for several desirable traits

including grain yield production.

The first cycle of recurrent selection was initiated during 1982-82 off-season by producing over 350 S_1's from each of the synthetic. These S_1 progenies were evaluated at Bambey during rainy season 1982. The selec ted S_1's (36 to 40) from each synthetic were recombined during off-season 1982-83 to produce 400 half sibs in IBV 8004 and 261 in Souna 3. These half sib progenies were evaluated during rainy season 1983 at Nioro, Bambey and Louga locations in single row plots. One replication was also planted in the disease nursery at Bambey. Based on performance over three locations and disease nursery, 36 progenies from each synthetic were selected for recombination. The selected half sibs (using S_1 seed from downy mildew free plants) were recombined during the off season 1983-84. During first and second cycles of recurrent selection, the selec ted progenies were recombined by bulk pollinating (mixing the pollen from all entries) equal number of plants in each entry. During 1984 rainy season, 432 half sibs from each synthetic were evaluated in two locations in single row plots. One replication was also planted in disease nursery at Bambey. Souna 3 was planted at Nioro and Bambey whereas IBV 8004 at Bambey and Louga locations. Thirty-six half sib progenies (using S_1 seed from downy mildew free plants) from each were selected and are being recombined during 1984-85 off-season by intermating the progenies in all possible combinations. The synthetic bulks Cl to C_3 are being prepared by mixing the equal quantity of half sib seeds obtained af ter recombination. The final comparison between improved and original synthetics will be made during the rainy season 1985.

IBV 8001, another selected synthetic was improved for deairable traits during the course of seed multiplication following gridded mass selection with a selection intensity of 10%.

A dwarf experimental variety, 3/4 HK-B78 (derived from Heine Keire, Niger) was improved for uniformity during 1980-81 and 81-82 off-seasons. All the tall plants, and the plants with small heads were removed before flowering. The improved version after mild selection during the seed multiplication in 1983-84 off-season was named IBMV 8401. This variety needs an improvement for grain size and resistance to smut and therefore is being improved by limited backcrossing. IBMV 8401 was crossed onto two lines from Ghana, 16151 and 16152, during 1983-84 off-season and the F_1's wera grown

during 1984 rainy season. The backcross 1 seed (F_2 x IBMV 8401) will be produced during rainy season 1985. After BC3 F2 generation, the selected progenies will be bulked to produce new IBMV 8401, with bold grains, resistant to smut and other desirable agronomic traits.

3.4. Breeding for Diseases and Pests Resistance

Major diseases in Senegal are downy mildew (Sclerospora graminicola), smut (Tolyposporium pennicillaria) and ergot (Claviceps fusiformis). Downy mildew and smut were observed almost everywhere (except northern region) in farmers fields in last several years. Occurrence of ergot was observed oply on late plantings or in specific years, when rains coincide with flowering, as in 1982 in central northern region of the country. The most important pest is Reghuva (R. albipunctella) which substantially reduces grain yield production particularly in early maturing ear heads.

Breeding for resistance to diseases and pests was initiated in 1981 in collaboration with GAM millet pathologist and CILSS entomologist. Since 1983, we have created artificial disease nursery at Bambey for screening against downy mildew and smut.

The following types of materials were screened in disease nursery:

-Routine evaluation of all elite products.

-Evaluation of progenies derived from two synthetics under improvement through recurrent selection.

-Conduct regional and international disease nurseries (IPMDMN and IPMSN). Since 1983, these disease nurseries were conducted by GAM pathologist.

Few entries which were in advanced stage of breeding are being extensively screened against possible pests.

3.5 Breeding for Drought Resistance

The attempts are being made to develop drought resistant varieties by inducing earliness. The results will be discussed along with breeding for high yield.

3.6 To Develop Cultural Practices for Optimizing Grain Yield Production

A multidisciplinary project involving millet physiologists from ICRISAT

Sahelian Centre and ISRA, and a soil chemist from ISRA was initiated in 1983 to determine the appropriate spacing, fertilizer dose and plant population for newly developed synthetics. The experiment was conducted for three years at Bambey and the experimental details are given below:

Four varieties-Souna 3, H7-66, IBV 8004, and IVS 54 54 (replaced by IBMV 8401 in 1983 and 1984) were tested in a replicated yield tria1 at three spacings (90X90, 90X60, and 90X30 cm) with same plant populations (37020 plants/ha) and at two levels of fertility (61N:31P20$_5$:31k$_2$0; and 33N:21P$_2$0$_5$:21K$_2$o Kg/ha) during 1982 to determine the appropriate spacing and fertilizer dose for new synthetics. The following year, the experiment was modified and continued for another year. Four varieties were planted at two spacings (90X90 and 90X45 cm) with two plants per hill and at three levels of fertility (0; 33:21:21; 61:31:31 Kg/ha). This experiment was planted in *six* to eight replications in a split split plot design. Thc emphasis on testing for precision in 1982 was in order of varieties (most), followed by spacing and fertilizer dose. This was due to simplicity also in conducting the experiment when fertilizer was the main plot. During 1983, spacing and its interactions were estimated with most precision followed by fertilizer and varieties. Based on results, the prioritites were changed in 1984 as in 1982.

4. ORGANIZATION FOR RESEARCH

Main Location: Centre National de Recherches Agronomique de Bambey, B. P. 53 Senegal

Testing Centres: Nioro, Louga and Darou.

Staff ing

Subhash Chandra Gupta	Pearl Millet Breeder	May 1980
A. Lambert[a]	Pearl Millet Breeder	January 1977
Mamadou Abdou Mara[b]	Technical Assistant	July 1978
Papa Amadou Diop	Technical Assistant	February 1977
Moussa Cissoka	Technical Assistant	February 1977
D j ibryl Guene	Field Assistant	March 1977
Maga Thiam[c]	Field Assistant	March 1977
Ahmat Nd iaye	Field Assistant	October 1984

[a,b,c] Left ICRISAT in April 1980, April 1982 and February 1984, respectively.

5. RESULTS

5.1 Introductions and Local Collections

A list of International trials and nurseries conducted in Senegal since 1977 is given in Table 1. The introduced material can be grouped into the following categories:

-200 diverse lines in 1977,
-Composite progeny trials from 1977 to 1979,
-Various yield trials from ICRISAT Center,
-F_1 crosses and segregating progenies,
-ICRISAT millet zonal adaptation tria1 since 1979,
-Pearl Millet exchange nursery since 1979, and
-Striga nursery and male steriles.

5.1.1. Diverse lines. Two hundred diverse lines were introduced in form of nurseries (advanced progenies, restorer lines, downy mildew free lines, breeder physiologist nursery and drought nursery) in 1977, This material was evaluated during the 1977 off-seaspn, and then during the 1977, 1978 and 1979 rainy seasons. These introductions were mainly of Indian, Nigerian, and Ugandian origin. The main conclusions were: the Nigerian material had high yield potential coupled with better resistance to diseases, the Ugandian material was early with t'hick heads and bold grains whereas the Indian introductions were highly tillering type, thin stems, medium plant height and small ear heads. Selected entries were crossed onto GAM material.

5.1.2. Composite improvement. Through recurrent selection was one and is one of the main activities of the pearl millet improvement program at ICRISAT Center in India. Multilocational testing can offer a unique contribution in the selection of durable disease resistance and for wider adaptation in semi-arid tropics. Therefore, we started composite progeny testing program in various West African locations coordinated by ICRISAT Center. Different composites were sent in different years to various locations to provide diverse material as much as possible. The selected progenies from each were recombined ta form location specific experimental varieties which were evaluated in the following year yield trials. Since composite prageny testing

program was too much resource consuming and therefore this program was discontinued in 1980. The priorities were changed to develop our awn material more and more by involving local germplasm in crossing program.

5.1.3. Various yield trials. Various traits originated at ICRISAT Center (India) were conducted in Senegal. Selected materials were used either in crossing program or for yie ld evalua tion in national yield trials. Various breeding products such as experimental varieties, hybrids and synthetics were tested first in individual yield trials and then the selected entries were tested in Elite varietïies tria1 (ELVT) and International Pearl Millet Adaptation tria1 (IPMAT).

Pearl millet synthetics trials were conducted from 1977 to 1981. Based on performance over 1978 and 1979, ICMS 7819 (17% superior to Sauna 3 in terms of grain yield) was selected for further evaluation, None of the entry was found superior to local check in 1980 and 1981, Pwarf varieties (D_2) were evaluated during 1980 and 1981. 3/4HK-B78 gave highest grain yield in both the years and was selected for further testing, It is important ta mention that this variety performed best among dwarf material, however, a tall check like Souna 3 was not included in the trial.

ELVT was conducted at Bambey since 1979 for three years. Performance data on grain yield for eight top yielding entries in each year is presented in Table 2. Several entries gave grain yield equivalent to Souna 3 but none of the entry was significantly superior to Souna 3. However, in 1980 trial, ICH 165 was significantly superior to Souna 3 in terms of grain yield production.

IPMAT was conducted in Senegal from 1975 to 1981. Many entries changed from year to year and none of the entry was common from 1975 to 1981. The grain yield performance for top five entries including check in each year is presented in Table 3. As in ELVT, several entries produced grain yield equivalent t o Souna 3 in different years but none of the entry was significantly superior to Souna 3. Most of the entries were seven to ten days earlier in maturity with shorter heads.

5.1.4. Fl crosses and segregating progeoies. It was realized that it is necessary to introduce only a Limited number of material from ICRISAT Center (India) mainly in form of F_1s and F_2 pop ulations rather importing yield trials. During 1981, 120 Fl crosses between African x African material and

more in 1983 were introduced to our program. Out of 120 crosses, 30 were selected which were advanced by pedigree selection. The most common parents were Togo short, Souna and Siria Korola Souna.

5.1.5. IMZAT. International millet zonal adaptation trial was initiated in 1978 for evaluating the performance of selected genotypes across West Africa. In the beginning, most of the genotypes were contributed by ICRISAT Center (India) which were identified suitable for certain locations in West Africa (in the earlier evaluations). Since 1981, millet breeders working in West Africa have contributed their best genotypes to this trial. This has provided an opportunity also to exchange the advanced genetic material generated in different programs. The performance data on grain yield averaged over three locations from 1980 to 1984 are presented in Table 4. During first three years of testing, none of the entry gave grain yield higher than Souna 3 and farmers local. During 1983, three entries-IBMV 8302, ITMV 8002 and ITMV 8001 produced more grain yield than Souna 3 and farmers local but none of them was significantly superior to checks. Dur ing 1984, the highest yielding entry was INMV 8210 (1796 kg/ha, 11.6% superior to best check IBV 8001) followed by INMV 8220 and INMV 8240. Farmers local and Souna 3 suffered most from drought and were the least yielding entries. Performance data for five characters for two years are presented in Table 5. It is important to note that during 1984, Nigerian material (INMV) was earliest to flower and escaped from drought at the time of flowering. During 1983, Nigerian material flowered the same time as Souna 3 and farmers local, and the yields were same as local checks. Among Senegalese material (IBV/IBMV in Table 4 and 5), IBV 8004 was evaluated during 1981 and 1982 trials. This synthetic gave grain yield quite close to checks, but was earlier to flower and resistant to downy mildew. IBV 8001 was included in the trial in 1981 and 1984. Based on two years data, this variety gave higher grain yields as compared *to* checks. IBMV 8301 and 8302 were evaluated during 1983 and 1984 and both synthetics gave grain yield equivalent to Souna 3. IBMV 8301 was earlier to flower and was highly resistant to downy mildew. IBMV 8302 was close to Souna 3 for all agronomic traits, Materials from Niger (ITMV) were well adapted to Senegalese conditions and gave grain yield production equivalent to checks. The materials from Burkina Faso, IKMV 8201 and 8101 were earlier in flowering, resistant to downy mildew and gave grain yield equivalent ta checks. The material from Sudan *was* included in

this tria1 in 1982 and 1983 and all the entries were least yielding entries with shorter heads

5.1.6. PMXN. Pearl millet exchange nursery was initiated in 1979 with the objective of rapid exchange of breeding material such as F_3, F_4 progenies or unfinished varieties among millet breeders working in West Africa. 1979 year results indicated the bad adaptation of material from Sudan and the good adaptation of Niger material. During 1981 and 1982, none of the entry was superior to Sauna 3. It was expected since most af the material was unfinished products or segregating progenies. The entries from Niger such as XTV 8107, ITV 8112 and ITV 8114 were selected in 1981 and such as INMB-2 and INMV 2-3 in 1982. PMXN of 50 entries was conducted at three locations-Nioro, Bambey and Louga during rainy season 1983. Five F_4 bulks from Senegal-$F_4$5B, $F_4$7B, $F_4$11B, $F_4$16B and $F_4$20B and one inbred from Sudan, ISMI 200, were selected for utilizing in breeding program. During 1984, among varieties, the highest yielder was IBMV 8406 followed by ITMV 8303, IBMV 8405 and IBMV 8402. The top yielding eight inbreds were from Senegal and the first four were ICMI 84022 SN, 84015 SN, 84009 SN, and 84011 SN based on head weight and the resistance to downy mildew. ICMI 84015 SN bristled gave head weight equivalent to Souna 3, and was resistant to downy mildew.

5.1.7. Striga nursery. Striga trials coordinated from Burkina Faso were grown at Louga during rainy seasons of 1982 and 1983 to evaluate the Striga incidence. Both the years there was no IStriga incidence at Louga. n general, Striga is not a problem in Senegal but the incidence was observed in dry years in certain areas of the country.

5.1.8. **Male-steriles.** All the male-sterile lines introduced from ICRISAT Center in 1980 were not adapted to Senegalese conditions. They were generally poor in appearance and were highly susceptible to smut and ergot. Fourteen pairs of A/B lines were evaluated in'1983. Based on visual observations, only three pairs--111 A/B, 81 A/B, and 1055 A/B were retained for further utilization. Fifteen A/B pairs from ICRISAT Center, India, two A/B pairs from Fort Hays experiment station and 50 F3 progenies derived from crosses among B lines at Fort Hays were evaluated at Nioro and Bambey in 1984, 1644 A/B were susceptible to downy mildew at both the locations. The remaining 14 pairs

from ICRISAT Center including 111 A, 81 A and derivatives from J1623x 3/4 Ex Bornu crosses were susceptible to downy mildew at Nioro and resistant at Bambey. Two A/B pairs (based on PI 185642 D_2) from Fort Hayç were 100% susceptible at Nioro and highly susceptible at Bambey. The F_3 progenies from Fort Hays were earliest to flower, short plant stature, highly susceptible to downy mildew and with bold grains. It will be worth growing F_2 populations among B lines and select plants for downy mildew resistance, long head, bold grain and high tillering ability.

5.1.9. Germplasm. In the beginning of the program (1977 to 1979), selected genotypes of different maturity groups (cycle 60 to 90 days) generated by GAM/IRAT were used in crossing with introductions from ICRISAT Center. In all, 17 genotypes were selected. Souna 3 was tall (plant height 220 cm) and the remaining 16 were dwarf (121 to 144 cm). These entries were Sl 601, Sl 602, S_1 603 (cycle 60 days), SYN 3-2, 16715, 16576 (75 days), M142, M144, M145, Ml46 (85 days), 15356, 15434, 15113, RL90, 3/4 HK and 3/4 Ex Bornu (90 days). During 1981, 225 germplasm collections, collected by ORSTOM were introduced into Senegal from ICRISAT Center (India) and were evsluated in rainy seson 1981 at Bambey and Nioro locations. T e n (P1415, P1432, P1461, P1473, P1595, P1518, P1531, P1558, P1559, and P1404) were selected for using in crossing program. Germplasm lines maintained by GAM were evaluated at Louga during 1981. We have selected 14 (SL 165, 115, 140, 86, 59, 60, 199, 214, 146, 215, 94, 309, 116, and 104) for using in crossing program, Twelve improved lines were contributed by GAM (H7-116, H9-127, H18-83, H24-38, H4-24, HI-66, H7-88, H9-124, H8-32, H12-30, H14-71, and H24-35), which were the best performing in 1981. We have collected 24 germplasm lines from early millet growing areas of Senegal during October 1981 (CSM 28 to CSM 51). This group of total 60 collections was named as Senegalese material. Germplasm 1 ines were also collected in November 1981 from south and south central regions of Senegal. All the 51 collections including 24 collected in October 81 were evaluated for their per se performance in two trials during rainy season 1982. The results are presented below:

A replicated tria1 of 36 Souna collections including two checks was conduc ted at three locations-Nioro, Bambey and Louga. Based on three locations, none of the collection was significantly superior to Souna 3. However, two collections CSM 35 (2.01 kg/8.1 m^2), and CSM 34 (1.92 kg/8.1 m^2)

produced equivalent grain yields as Souna 3 (1.91 kg/8.1m^2). In individual environment, Souna 3 ranked 12th at Nioro, 2nd at Bambey, and 16th at Louga in terms of grain yield production. It is important to mention that both the collections came from very dry areas of Senegal (Richard-Tall). A replicated tria1 of 18 Sanio collections including a local check was conducted at Sefa during the rainy season of 1982. Al 1 the collec tions had low grain yield, were late and tall, with short to medium ears, low seed weight and were highly susceptible to downy mildew and smut. Nothing of interest worth transfarring to Souna types was found in the Sanios.

5.2. Breeding for High Yield

-Development of inbreds

-Synthetics

-Hybr ids

5.2.1. Development of iabreds. Four hundred and one inbreds/partial inbreds were evaluated in four multilocational yield trials during 1984, Performance of 54 inbreds derived from crosses generated in 1977-78 off-season for seven charac ters averaged over two locations are presented in Table 6. The differences among inbreds were highly significant f o r all the seven characters-head weight, days to 50% bloom, plant height, ear length, downy mildew and smut incidences, and seed size. None of the inbred was signif icantly superior to Souna 3 in respect of head weight, The highest yielding inbred was ICMI 80025 SN followed by ICMI 80043 SN and ICMI 80004 SN. Ten inbreds gave head weight equivalent to Souna 3. *There was* tremendous variation for plant height but most of the inbreds had medium head length (27 to 42 cm). None of the inbred was totally free from downy mildew and smut. The 1000 seed weight varied from 2.9 to 7.5 g.

The performance of 48 F_4 derived F_5 progenies derived from crosses genera ted in 1980-81 off-season for seven characters averaged over two locations - Nioro and Bambey are presented in Table 7. The differences among entries were highly significant for all the characters. The highest yielding entry was ICMI 84029 SN follotred by 84050, 84046, 84015, 84007, 84016, 84048, 84022, and Souna 3. Based on days to 50% bloom, all the entries were in early (75 to 80 days to maturity) to medium maturity (90-95) group. Most of the entries had medium plant height and ear length. The mean downy mildew

incidence of tria1 was 12.1% and only two entries had incidence less than 5%. However, 29 entries had significantly less downy mildew incidence as compared to Souna 3. Six entries had smut incidence less than 5% whereas the mean incidence of tria1 was 9.8%. Two entries - ICMI 84053 SN and 84045 had seed weight significantly higher than Souna 3 and all the remainings except one had equivalent to Souna 3.

Performance data of 94 F_4 derived F_5 progenies derived from crosses generated between Senegalese vs non-Senegalese materials for ffve characters at Bambey are presented in Table 8. The differences among entries were highly significant for all the characters-head weight, days to 50% bloom, plant height , ear length, and downy mildew incidence. The head weight production was very low coupled with high coefficient of varition due to late planting and poor germination. Most of the entries took more time to flower, however, three entries flowered in less than 50 days. Six entries were very late and did not attain bloom until the harvesting of the trial. Souna 3 was only 185 cm tall and the mean of the tria1 was 158 cm. This reduced height was the effect of drought. Four entries-ICMI 84091 SN (head length 49 cm whereas Souna 3, 42 cm), 84062, 84024, and 84057 had head length close to Souna 3. It is interesting to note that 24 entries were completely free from downy mildew whereas Souna 3 was highly susceptible (28%). Data were not recarded for smut and 1000-seed weight as the seed setting under bagged heads was very poor.

Performance of 200 F4 progenies derived from crosses generated between Senegalese vs non-Senegalese material during 1981-82 off-season for five charac t ers averaged over three locations are presented in Table 9. The dif ferences among entries for all the five characters were highly signif icant . The best performing entries were ICMI 84207 SN, 84167, 84192, 84194, and 84282 which were equivalent to Souna 3 in respect of grain yield production. Souna 3 was highly susceptible to downy mildew (18% incidence) whereas 42 entries were completely free from downy mildew. Most of the entries fall in early and medium maturity groups. As Indicated by the tria1 mean, most of the entries had shorter plant height and head length as compared to Souna 3. However, six entries had head length higher than 50 cm.

5.2.2. **Synthetics.** The results of the following three trials will be discussed in the following paragraphs.

-Senegal Regional Tria1 conducted during rainy season 1980.
-Joint Yield Tria1 conduct.ed for 4 years (1981 to 1984).
-Preliminary Synthetics Trial conducted during rainy season 1984.

Senegal Regional Trial. Performance data on grain yield in individual environment are presented in Table 10. The highest yielding entry was synthetic IBV 8004 (41.1% superior to Souna 3) followed by IBV 8001 (31.2%), ICMS 7819 (11.7%), and D_2-BB78-I (6.4%). The synthetic IBV 8004 ranked first in terms of grain yield production in all the locations and was significantly superior to Souna 3 in each of the environment under test. The other synthetic IBV 8001 was significantly superior to Souna 3 in respect of grain yield production at Nioro and Bambey. These two synthetics had reduced plant height, early in flowering, high seed weight, and better resistence to downy mildew as compared to check - Souna 3. The coefficient of variation for grain yield was lowest at Nioro and the highest at Louga, Balanced lattice design was found substantially efficient over completely randomized block design (51.8% at Louga and 17.5% at Bambey). Three synthetics - IBV 8001, IBV 8004, and ICMS 7819 were retained for further testing in joint yield trial.

Joint Yield Trial. The three synthetics selected from above trial, along with four entries from GAM and two checks were evaluated at four locations during rainy seasons of 1981 to 1984. One genotype IBMV 8401 was added in this tria1 during 1982. Mean squares for seven characters-grain yield, days ta 50% bloom, plant height, ear length, seed weight, downy mildew, and smut incidences are presented in Table 11. Mean squares for genotypes (G), locations (L), years (Y) and their interactions were significant (comparing pooled error) for all the characters except G*Y for grain yield. G*L interactions were larger than G*Y and G*L*Y for all the characters except for grain yield and smut incidence. However, for grain yield, G*L*Y interaction was larger than G*L. It is interesting to note that the differences among years were about two times greater than the differences among locations for grain yield production.

Mean performance of ten entries in multi-locational yield trails averaged over years and locations for seven characters are presented in Table 12. The highest yielding genotype was IBV 8001 (1759 kg/ha, 16.87% superior to Souna 3) followed by H7-66 (1695 kg/ha), and IBV 8004 (1677 kg/ha). All the three

genotypes were significantly superior to checks at 1% level of significance in terms of grain yield production. The regression values of genotypes on environmental indexes were not: significantly different from one which shows the genotypes tended to be responsive at favorable environments. Eased on stability parame ters, IBV 8001 and H7-66 were highly stable in performance over locations and years. (Table 12). However, IBV 8004 due to its earliness (in maturity for 7 to 10 days than Souna 3) is more suitable for drier zones (region of Thies and Louga) or when the season starts late. 411 the three varieties had shorter plant height, earlier in flowering, higher seed weight, and better resistance to downy mildew as compared to checks. However , all the genotypes need an improvement for smut resistance and head length. These three genotypes do not differ statistically from each other in terms of grain yield production. A d_2 dwarf variety IBMV 8401 gave grain yield equivalent to checks during the last three years but it was inferior to TBV 8001, a medium tall genotype.

In Table 13, the grain yield data of individual geneotypes in different locations averaged over years are presented. At Nioro, the highest yielding genotype was IBV 8001 fol lowed by H7-66 but none of the genotype was signif icantly superior to checks. However, IBV 8001 produced 7.8% more grain than bes t check, Souna 3. At Darou, none of the genotype was significantly superior to farmers local. However five genotypes including farmers local were significantly superior to Souna 3. The highest yielding genotype was IBV 8001 followed by IBV 8004. H7-66 gave highest yield at Bambey and was significantly superior to best check. IBV 8001 ranked second at Bambey. IBV 8001 was significantly superior to the best check-farmers local at Louga location. Based on productivity in different environments, the environments were classified into eight highest yielding and the eight lowest yielding. The results are presented in Table 13. Examining the mean performance of genotypes in highest yielding environments, the highest yielding genotype was IBV 8001 followed by H7-66 and IBV 8004. The first three genotypes were significantly superior to Souna 3 and only IBV 8001 was significantly superior to farmers local. In lowest yielding environments, only IBV 8001 was significantly superior to best check, Souna 3. H7-66 ranked second followed by H9-127 and IBV 8004. It is important to note that Souna 3 did not exhibit any superiority for any character (except grain size) in any location over traditionally grown varieties.

Preliminary Synthetics Trial. Performance of preliminary syntheties tria1 test entries (newly generated in 1983-84 off-season) for grain yield (head weight x 0.7) at Nioro and Bambey and for six characters averagad over two locations are presented in Table 14. Based on mean over locations, the highest yielding entry was IBMV 8403 (1142 kg grain/ha, 69% superior to Souna 3) followed by IBMV 8406 (68%), IBMV 8404 (49%) and IBMV 8402 (46%). These four synthetics were significantly superior to Sauna 3 in respect of grain yield production. These synthetics were 7 to 10 days earlier in flowering, less suspectible to downy mildew and smut and 25 to 30% superior in seed weight as compared to Souna 3. It is important to mention that the tria1 suffered from drought at Bambey as well as Nioro, Therefore, low selec tion pressure was applied and nine entries were retained for retesting in rainy season 1985. A medium tall, bristled synthetic IBMV 8413 (only 36% superior to Souna 3) was eye catching and was selected along with IBMV 8406 for testing in CILSS regional trial.

The constituent lines for sellected synthetics are given below:

IBMV 8402: ICMI 84002 SN to 84005, 84007 to 84013, 84032, 84033 (90 days cycle)

IBMV 8403: 84014, 84015, 84020, and 84021 (Bristled)

IBMV 8404: 84016, 84022, 84034 (d_2 dwarf)

IBMV 8405: 84017 to 84019, 84023, 84025, 84035 (90 days)

IBMV 8406: 84001, 84006, 84024, 84026 to 84031 (75 days)

IBMV 8413: 84055 to 840513, 84060, 84062 to 84066 (Bristled)

IBMV 8414: 84067 to 840713 (d_2 dwarf)

All the above numbers have ICMI.. . . . SN indicating that they are ICRISAT millet inbreds developed in Senegal.

5.2.3 Hybrids. A tria1 of 28 hybrids (7 male sterile lines x 4 inbreds) plus 2 checks, replicated 5 times was conducted at Bambey during rainy season 1983. The mean of tria1 was 1148 kg/ha with high coefficient of variation (44.9%). Eight entries yielded more than Souna 3, however, none of, the entry was significantly superior to Souna 3 in respect of grain yield production (Table 15). All the hybrids were significantly less susceptible to downy mildew than Souna 3, but more susceptible to smut. All the hybrids were shorter in plant height and ear length as compared to Souna 3. Two male-

sterile lines (11 1A and 81A) and 2 testers IBMI 8108 and IBMI 8206 were the best general combiners in respect of grain yield production. Six hybrids were retained for testing in rainy season 1984. All the hybrids were fertile.

Eighty-nine hybrids along with parents were evaluated in an observation nursery at Bambey. Based on visual observations, 16 were selected for retesting. Two variety X line hybrids were selected based on performance in 1982 yield trial. A tria1 of such 24 hybrids plus 1 check replicated 6 times, was conducted at Nioro and Bambey during rainy season 1984. Based on mean over two locations, the tria1 mean was 1884 kg/ha with a coefficient of variation of '30.8%. Eight hybrids yielded significantly more than Souna 3 (Table 16). The highest yielding hybrid was ICMH 8407 (2575 kg/ha, 61% superior to Souna 3) followed by ICMH 8413, 8403, and 8411. The hybrids produced more ear heads than Souna 3 but smaller head length (Table 17). It looks that number of heads per unit area is an important selection criteria for improving pearl millet. Ten hybrids were retained for retesting in 1985 (Table 16). Two hybrids (ICMH 8403 and ICMH 8413 gave significantly higher grain yields than Souna 3 in 1.983 as well as 1984. Six hybrids selected in 1983 were also selected in 1984 for retesting in 1985,

One hundred and nine test crosses along with 55 parents were evaluated at Nioro and Bambey in unreplicated plots during rainy season 1984. Based on visual observations, head wei.ght, and other agronomic characteristics, 13 hybrids were selected for further testing in 1985.

5.3. Improvement of Synthetics. Performance data for synthetic population progenies selected for three cycles for six characters are presented in Table 18. The most important selection criterias for the improvement of Souna 3 were resistance to downy mildew, and the increase in grain yield production. Shibras were eliminated in the first cycle of selection itself. In the first cycle of selection, selection differential for grain yield was 38.2% and the downy mildew incidence reduced from 12.2 to 4.9% in selected progenies. In second cycle of selection, the main selection criteria was the resistance to downy mildew and only 11% selection differential was for grain yield. When we compared the different cycle bulks of Souna 3 (Table 19), the improvement in grain yield in first cycle was 19.6% of Co bulk whereas in second cycle it was only 8.7% comparing with original population. However , the downy mildew

incidence reduced from 16.4 to 14.2% in first cycle and to 9.8% in the second cycle.

IBV 8004 was improved for grain yield production and the resistance ta diseases. The selection differential for grain yield was 34 to 42% in different cycles of selection (Table 18). However, in two cycles, IBV 8004 was improved only by 3.3% for grain yield production and there was slight improvement for smut resistance (Table 19). It is interesting to note that IBV 8004 produced 25 to 30% higher grain yield than Souna 3 in each cycle of selection (Table 19).

During third cycle of selection, heavy selection pressure (8%) was applied for grain yield and the selection differential was 30 to 35%. The list of selected half-sib (HS) progenies during 1984 from both the synthetics are given below:

Souna 3: HS 1, 35, 46, 70, 73, 78, 91, 116, 122, 123, 139, 145, 157, 162, 169, 186, 199, 210, 221, 231, 244, 255, 274, 278, 306, 329, 336, 346, 367, 382, 397, 403, 412, 427, 424, and 88,

IBV 8004: HS 1, 16, 23, 34, 37, 95, 103, 119, 121, 126, 144, 153, 158, 159, 197, 212, 228, 236, 246, 263, 279, 284, 293, 311, 322, 324, 334, 347, 348, 370, 380, 386, 398, 406, 409, 426,

5.4. Breeding for Diseases and Pests Resistance

5.4.1. Disease resistant material. Four hundred and ninety-five disease resistant plants with self heads were selected from various yield trials and nurseries planted during rainy season 1981. These selfed progenies were grown in single rows in rainy season 1982 for morphological evaluation. Eighty-one S_2's derived from this material were grown during rainy season 1983 in four environments - Nioro, Bambey, Louga, and Bambey disease nursery. Based on performance data, 13 S3 progenies were selected which were utilized as component lines along with 18 F_4 progenies to generate five synthetics (IBMV 8402 to 8406). During 1983-84 off-season, these 13 S_3 progenies were also crossed onto male-sterile lines to discover their hybrid potential. The list of lines along with their origin is given on the following page:

Number	Originated from	Origin
ICMI 84017 SN	Souna 3-1	Senegal
84018	ITV 8002	Niger
84019	NELC-A79	ICRISAT Center, Ind ia
84020	SSC 9114	Uganda via ICRISAT Center
84021	SRC-P1505	ICRISAT Center
84022	1038	ICRISAT Center
84023	VCF_4 9-5	ICRISAT Center
84024	IP2253 x 3/4 EB237-3	ICRISAT Center
84025	El3137 x EB 117	ICRISAT Center
84030	Souna 3-2	Senegal
84031	Togo Short 3	Toga via ICRISAT Center
84034	GIN 615-lx GlN 191-2	Senegal
84035	WC FS 148 S_1 DM_1	ICRISAT Center

The performance of these lines are presented in Table 7 and 8 along with the inbreds developed from crosses among selected GAM x Indian derived lines and the in troduc t ions. ICMI 84029 SN and 84022 were the best among 13 for grain yield production.

5.4.2. Improvement of synthetics. Population progenies from two synthetics - Souna 3 and IBV 8004 were planted in single rows in disease nursery at Bambey during 1983 and 1984. Disease data were utilized along with other agronomical traits for selecting the progenies for recombination. The results are presented along with others in the section 5.3.

5.4.3. International nurseries. Two disease nurseries- IPMDMN (Downy mildew), and IPMSN (Smut) were conducted in Senegal. Since 1983, these nurseries are being conducted by GAM millet pathologist at Bambey. IPMSNwas conducted since 1980 at Bambey. Most of the lines had low incidence of smut but were not agronomically desirable for immediate exploitation. All the lines developed by ICRISAT millet pathology program with ICMPS had smut incidence less than 3%. The lines derived from Ex Bornu were also resistant

to smut. The lines with "P" numbers such as P20-S-1, P427-S_1, P489S_3 were moderately susceptible (20 to 30%) to smut.

IPMDMN was conducted since 1981, initially for one year at Nioro and then at Bambey location. Thirty to 36 entries out of 46 had downy mildew incidence less than 5% in different years. In all the three years, the highest susceptible entry was 7042 (incidence 74 to 98%). Only few entries were selected for using in breeding program.

5.4.4. Pest nursery. Entries of joint tria1 and the other aelected entries such as ICMS 7838, and ICH 165 were evaluated against Raghuva at Nioro by Dr. R. T Gahukar, CILSS entomologist since last three years, IBV 8001 and IÇMS 783% were resistant to Raghuva and the highest yielding entry in their tria1 was IBV 8001 (2029 kg/ha). ICMS 7838 was most susceptible to smut (34%). Souna 3 and H24-38 were highly susceptible to downy mildew (15 ta 19% plants attacked whereas in IBV 8001 only 1%). In three year trials, IBV 8001, 10 days earlier to Souna 3 in maturity was found most tolerant variety to Raghuva.

5.5. Development of Agronomic 'Practices for Optimiziag Yields

Mean squares of genotype x fertilizer x spacing trial (for five characters) planted in split split plot design during rainy seasona of 1982 to 1984 at Bambey are presented in Table 20. The differences among genotypes were significant for all the five characters - grain yield, days to 50% bloom, plant height , ear length, and downy mildew incidence in all the three year trials except for grain yield in 1983. The differences between dose of fertilizers were significant for grain yield in 1982 and for downy mildew incidence in 1983. The spacings differ significantly in all the three years for ear length and downy mildew incidence, and in 1983 and 1984 trials for days to 50% bloom. For grain yield, the differences between spacings were significant in 1984, and at 0.0513 probability level in 1982. The differences between spacings were also significant for plant height in 1983. Two factor interactions - spacing x fertility, genotype x spacing and genotype x fertility were not significant except for downy mildew. The interactions due to genotype x spacing were significant in all the three years and whereas the interaction due to genotype x fertility was significant only in 1983, Three factor interactions were not significant except for plant height in 1982,

Mean performance of different genotypes, spacings, and fertility levels for grain yield, days to 50% flowering, and plant height in Table 21 and ear length and downy mildew incidence in Table 22 a,re given. There was no significant difference between H7-66 and IBV 8004 in respect of grain yield production. Souna 3 was significantly superior to IBV 8004 and H7-66 in 1982 , but was significantly inferior in 1984. In 1982, all the three genotypes were significantly superior to IVS 5454, an earliest entry ta flower. IVS 5454 was , replaced by a d_2 dwarf genotype IBMV 8401 during 1983 and 1984. IBMV 8401 gave grain yield equivalent to Souna 3 in both the years, However, Lt was significantly inferior to IBV 8004 and H7-66 in 1984, Souna 3 was significantly tall, longer ear heads, and late in flowering as compared to rest of the genotypes. IBMV 8401 was significantly dwarf than other genotypes. IVS 5454 was highly susceptible to downy mildew. During 1983 and 1984, Souna 3 was significantly more susceptible to downy mildew incidence as ,compared to IBV 8004, H7-66 and IBMV 8401.

The high fertility (61:31:31 kg/ha) produced significantly higher grain yield than the low fertility level during 1982. However, we did not observe any ef fect of increased level of fertility on grain yield production during 1983 and 1984. The high fertility.level also increased significantly downy mildew incidence as compared to control during 1983. However , there were no differences in grain yield production at different levels of fertility in 1983. There was no effect of different levels of fertility on flowering, plant height and ear length.

It is important to note that the grain yield production at 90 x 90 cm spacing (2 plants per hill) was significantly higher (40%) than at 90 x 45 cm spacing (2 plants per hill) during 1984. However , during 1982, the 90 x 30 cm spacing produced significantly higher grain yield than at 90 x 90 cm spacing. There were no significant differences in 1983. At 90 x 90 cm spacing, the ear heads were signifianctly longer coupled with increased incidence of downy mildew in all the three years. For downy mildew incidence the coefficients of variations were very high (55 to 163%) with low mean (1.4 to 8.7%) in different years. At 90 x 90 cm spacing, the genotypes were tall by 6 to 7 cm and one day earlier to flower.

6. DISCUSSION

I would like to mention certain points regarding the prevailing climatic conditions in the last five years in different millet growing regions in Senegal. The total rainfalll and its distribution at research stations where millet trials were conducted from 1980 to 1984 are given in Table 23, During 1980, the trials were conducted at three locations-Nioro, Bambey, and Louga (Fig. 1). From 1981, Darou was included as a testing site. All the experiments were planted just after one good rain (about 20 mm), The planting period varied from location to location and year to year. During 1980, the season started 4 to 6 weeks late due to late arriva1 of rains. While in 1981, the crop was planted 2 weeks earlier than normal time at Bambey. During 1982, the season started on time only at Bambey and was two weeks earlfer at Louga but delayed by 3 to 4 weeks at Nioro and Darou. In spite of so much variation in planting dates, the crop growth was satisfactory in all locations except for Louga as indicated by high tria1 means and low coefficient of variations during 1980 to 1982.

During 1983, the total rainfall was about 250 to 300 mm less at each location. The early maturing varieties suffered most at Nioro because of drought at flowering stage. At Darou, the initial growth was poor because of drought at seedling stage. At Bambey, there was drought for 50 days just after planting. Ninety-five percent hills were standing but the growth was poor and the flowering was delayed by 15 to 20 days. At Louga, there was drought the whole month of September and October, and the rainfall (146 mm) was lowest in the last 66 years. The poorest crop was at Louga. During 1984, the total rainfall was sufficient at Nioro and Bambey but the distribution was erratic. There was drought during second fortnight of August and early September which coincided wi.th flowering and grain filling period. The crop growth was satisfactory at Darou. At Louga, the germination was satisfactory but many plants died due to sand blast and a drought for 40 days. In all the years, the crop was poor at Louga, (northern region of Senegal) and was very poor during 1983 and 1984. In the following paragraphs, the results will be discussed.

6.1. Introductions and Local Collections.

Since 1970, the emphasio of national program was mostly on creation and utilization of d_2-dwarf material. ICRISAT, in collaboration with ISRA, started its program to diversify the genetic base, ICRISAT introduced and

evaluated the best material under the ecological conditions of Senegal-and subsequently recombined the best with the selected GAM (including local germplasm) material. In the beginning, ICRISAT emphasis was on conducting yield trials originated at ICRISAT Center and select the material for immediate utilization in Senegal. Introduced material was earlier in maturity coupled with small heads and susceptible to Raghuva. Several entries gave grain yield equivalent to Souna 3 but none of them was significantly superior to Souna 3 except ICH 165 in 1980 in ELVT. Across five trials, ICH 165 was only 1% superior to checks during 1980. The most promising entry was ICMS 7819 during 1978 and 79 trials (17% superior to check) which gave more grain yield than Souna 3 in yieldi trials during 1980 to 1984, By then, new genotypes developed by us whic'h were higher yielding than ICMS 7819. Among d_2 dwarf material., 3/4 HK-B78 was most promising. We found much use of introduced material in generating new material by crossing among themselves and with local materials. Since 1982, there was drastic reduction in importing yield trials from ICRISAT Center and the emphasis was given to introduce only limited material such as Fl crosses (African x African), F_2 populations, drought resistant lines, and male-sterile lines. The selected material was utilized in our program.

Besides ICRISAT Center, the genetic material was also introduced from various millet breeders working in Africa. This was mainly in form of regional trials and exchange nurseries. ICRISAT scientists are working in six African countries-Senegal, Burkina Faso, Mali, Niger, Nigeria, and Sudan for the improvement of pearl millet. The best products from these centers along with the ICRISAT Center products identified through international testing program were tested in regional trials and exchange nurseries. Thia provides an access to the best identified material at different centers. The entries from Niger were similar to local material and were well adapted to Senegalese conditions. During 1984, the entries from Nigeria and Burkina Paso also perf ormed well. The material from Sudan was not adapted to our conditions, The reasons of poor adaptation could be earliness, very small heade and poor seed setting. The material bred in Senegal was identified in Mali, Nigeria, and Niger. This suggests that the material bred in Niger could be useful to Senegalese farmers. There is a need to confirm the results of entries generated in Nigeria and Burki.na Faso.

Male-sterile lines and maintainers were introduced from ICRISAT Center and Kansas State University. The A/B pairs were susceptible to diseases and had very small ear heads (except 111A). The maintainer lines (F_3 progenies) from Fort Hays were earliest to flower, highly susceptible to downy mildew but with bold grains. It will be worth growing F_2 populations among B lfnes and eelect plants for bold grains., high tillering, long heads and resistance to diseases. There is a need to develop A/B lines in African background.

'The germplasm lines were collected by us and earlier by ORSTOM. All the collections could be divided into two groups-Souna and Sanio. They are very different from each other. But within themselves, there was not much variation. We did not find any useful character in Sanio to transfer to Souna. Since there was not much variation within Souna collections, all the collections were used in crossing program. The material colkected from the northern region of the country performed best in yield trials. This may be because of natural selection for resistance to drought. There is a need to make more collections from northern region where the crop is disappearing fast. I would like to mention that 1 did not observe any difference in maturity among Souna collections when they were grown at a particular location. This suggests that the seed material grown from northern region to aouth central region is of the same maturity. However, the plant spacing differs from region to region to utilize the limited soil mofsture with an optimum plant population.

6.2. Breeding for High Yield

6.2.1. Development of inbreds. The national program was concentrated on exploiting the variability available within GAM material. To complement their research activity, we generated crosses among introduced material itself, and the introduced material with selected GAM lines including local collection. Until 1984, 401 inbreds were generated which were characterized for various agronomic traits . There were significant and large variations for the traits such a s reaction to downy mildew and smut, plant height, ear length, flowering, and seed size.

At different stages of the program, the lines were selected to generate synthetics and hybrids. The coefficients of variations for head weight were

high, therefore, all the inbreds will be retested in 1985. I would like to emphasize that we have not systematically and fully exploited the newly generated inbred lines. One hundred and sixteen inbreds were utilized to generate various synthetics and hybrids. These lines were selected on the basis of per se performance only.

6.2.2. Synthetics. The synthetics generated until 1980 were evaluated in multi-locational yield trials from 1980 to 1984 along with the best material developed by GAM program. Based on multi-locational data, the highest yielding genotype was IBV 8001 (1759 kg/ha, 16.87% superior to Souna 3) followed by H7-66 and IBV 8004 (Table 11). Based on stability paramerers, IBV 8001 and H7-66 were highly stable in performance (Table 12), IBV 8001 ranked first in all the locations (averaged over years) except Bambey where it ranked second. Based on results, IBV 8001 can be recommended to the entire millet growing zone where Souna is grown. To further confirm this, we divided 16 environments into two groups based on environmental index, highest yielding and lowest yielding environments. Based on mean over 8 environments, in each group, the highest yielding entry was IBV 8001 (Table 13). This suggests that this variety can equally grow in low yielding as well as high yielding environments and will produce more grain yield with improved environment. H7-66 ranked second at both productivity levels. IBV 8004 ranked third at highest productivity level and fourth at lowest productivity level. IBV 8001 had medium long heads but very compact. This variety was reported by Dr. R. T, Gahukar, CILSS entomologist, as resistant to Raghuva and highest yielding in his trials. IBV 8004 was 41% superior to Souna 3 in terms of grain production during 1980 whereas IBV 8001 was only 31%. During 1980, the season started very late, (planted on 6 August) and was a short season. IBV 8004 seems to be a suitable variety when the season starts late or only for the northern region of the country. Among dwarf material, PS 90-2 and IBMV 8401, bath gave grain yield equivalent to Souna 3. IBMV 8401 had major advantage over PS 90-2 of head leng th. IBMV 8401 was grown by farmers for seed multiplication in 15 ha during 1984 and they preferred because of its earliness (7 days), long heads, resistance to downy mildew, green leaves, and easy to carry out agronomic practices. IBMV 8401 needs an improvement for grain size and smut resistance.

Newly generated synthetics during off-season 1983-84 were evaluated

during rainy season 1984. The highest yielding entry was IBMV 8403 (1142 kg/ha, 69% superior to Souna 3) followed by IBMV 8406, IBMV 8404 and IBMV 8402. These synthe tics were significantly superior to Souna 3 in respect of grain yield production. 1984 was a drought year as indicated at the beginning of this chapter, and Souna 3 suffered most from drought. We did not include several checks of different maturity groups since we did not experience this in earlier seasons. Most of the entries of this tria1 will be retested in rainy season 1985. In coming years, IBV 8001 should be included as standard check plus Souna 3 in yield trials. One of the synthetic, IBMV 8433, a bristled type, was uniform for head type and was eye catching.

6.2.3. Hybrids. A small project was initiated in 1982 to develop suitable restorer lines for the production of hybrids. This was not with the objective of developing hybrid varieties for the release to farmers in near future but to find out the potentialities of the hybrids generated from Afsican material. So that when the seed companies are capable to produce hybrid seed economically, researchers have something to of fer. About 250 test crosses were generated using inbreds developed by us with several male sterile lines introduced from ICRISAT Center. During 1984, eight hybrids yielded significantly higher than Souna 3 (Table 16). The highest yielding hybrid was ICMH 8407 (2575 kg/ha, 61% superior to Souna 3) followed by XCMH 8413, 8403, and 8411. It seems that number of heads per unit area is an important selection criteria for improving pearl millet, The hybrids in general produced more number of ear heads but shorter head length than Souna 3. The synthetic variety IBV 8001 discussed earlier also had sharter head length than Souna 3 but produced more number of heads per unit area. The results on hybrids are of preliminary in nature but two hybrids ICMH 8403 and ICMH 8413 gave significantly higher grain yield than Souna 3 in 1983 as well as 1984, The limiting factor in the production of hybrids is the suitable male-sterile lines and later may be seed production. The male-sterile lines introduced are not adapted because of susceptibility to diseases, small heads, and are too early in flowering. Most of the test cross hybrids were fertile, It eeems that the frequency of genes for male sterility is very low in our material. Among introduced ms lines, 81A and 111A were retained for further utilisation.

6.3 Improvement of Synthetics

Three cylces of recurrent selection on two synthetics - Souna 3 and IBV 8004 *were* completed in the off-season 1984-85. Both the synthetics were not improved earlier and there were presence of many deleterious recessive genes, as it was visible from the variations in the synthetic populations. In first cycle, both the synthetics were improved through S_1 selection. Souna 3 was improved by 17% for grain yield production but IBV 8004 only 2%. Shibras were eliminated from Souna 3. For the next two cycles, the populations were improved through half-sib progeny selection. In our situation, it was possible to complete a cycle in a year. The selection of progenies was based on single replication in 2 to 3 locations. One of the important selection criteria was visual selection. The half-sib progenies were not randamized and a gridded mass selection was imposed over half-sib progeny selection. This allowed us to keep a materna1 control, to maintain the genetic variability and to minimize the environmental variations. In Souna 3, the most important selection criterion in second cycle was resistance to downy mildew and the selection differential for grain yield was only 11%. When compared, cycle 2 bulks with cycle 1 of Souna 3, there was no improvement in grain yield production, However , downy mildew incidence reduced from 14.2% to 9.8%. IBV 8004 was improved slightly every year for grain yield production, In third cycle, the main selection criterion was grain yie ld and the selection differential was 30 to 35%. The final comparison between original and selected bulks will be carried out during rainy season 1985,

6.4. Breeding for Diseases and Pests Resistance

This activity was carried out since 1981 in collaboration with ISRA millet pathologist and CILSS entomologist . One replication of all the yield trials and the composite progenies was planted in disease nursery. Entries of joint yield tria1 were evaluated against pests. The information gained on lines selected were used for breeding for high yield and for the improvement of synthetics. Two disease nurseries originated from ICRISAT Center for screening downy mildew and smut were conducted to find out the useful material.

From all the introduced material (trials, disease nurseries and inbreds as UPN), the lines were selected following selfing and selection for disease resistance. Thirteen lines were selected and used as a component lines for forming synthetics during 1983-84 off-season.

International disease nurseries were of greak value in terms of finding the new sources of resistance. Most of the lines were agronomically poor. This may be because of inbreeding depression. Few lines were utilized in crossing program.

Breeding for resistance to pests was not on our priority in Senegal due to limited resources. We checked the performance of advanced genokypes againsk tolerance to Raghuva. Normally, early maturing genotypes were more damaged by Raghuva than khe traditionally grown. We wish to brecd for earliness, (7 to 15 days), to avoid the drought at the end of the cycle. The synkhetic IBV 8001 was found tolerant to Raghuva and was 7 to 10 days earlier than Souna 3 in maturi ty. The heads of IBV 8001 are small (about 35 cm) but very compact . The avoidance mechanism might be playing a great role in this synthetic. It is important to mention that this synthekic was significantly euperior to Souna 3 in kerms of grain yield production during last five years multi-locational yield trials including pest nurseries.

6.5 Breeding for Droughk Resistance

Since there is a drought in most of the years in Senegal the breeding for drought resistance was an important objective of our program. Due to complex mechanism of drought resistance and absence of reliable techniques for screening for drought resistance, attempts were made to develop early maturing varieties such as IVS 5454 (cycle 70 days), IBV 8004 (75 to 80 days), IBV 8001 (85 days), and IBMV 8401 (85 to 90 days) to achieve this objective.

From our past experience, we have seen that the earliness is not the answer for breeding for drought resistance. Early maturing variekies performed better if the drought occurred at the end of the cycle or if the season started very late i.e. if khe duration of cycle is reduced. Drought may occur at any stage of the crop and if it is at GS1, the early maturing varieties suffered most from drought as compared to traditionally grown. Early maturing varieties are generally photo-insensitive and they don't have any mechanism to delay flowering or growth as such if there is drought at GS_1 and GS_2 stage. In my opinion, more efforts are needed to understand the mechanism of drought resistance and to screen the genetic material reliably for drought resistance at dif'ferent growth stages.

6.6 Development of Agronomic Practices for Optimizing Grain Yields

The trials consisting of four varieties at 2 to 3 spacings and at 2 to 3 fertility levels were conducted at Bambey to determine the proper spacing and proper fertilizer dose for newly developed (dwarf as well as medium tall) varieties for 3 years. Souna 3 was superior to H7-66 and IBV 8004 during 1982 but inferior in 1984 in terms of grain yield production. There was no significant difference between IBV 8004 and H7-66 for the production of grain yield. The rainfall distribution during 1982 was normal and the rains continued until 14 October. This was advantageous to Souna 3 because of its cycle and gave 13.5% more grain than IBV 8004. Whereas during 1984, Souna 3 suffered from drought at the time of flowering and was 47% inferior to IBV 8004 (Table 21). IBMV 8401 gave grain yield equivalent to Sauna 3 in both years of testing.

All the genotypes were responsive to high fertility (61 kg N, 31 kg P_2O_5, and 31 kg K_2O/ha) during 1982 as indicated by the significance among fertilty levels and the absence of G * F interaction (Table 20). However, there was no effect of fertilizers on productivity during 1983 and 1984. There could be two possible explanations for this phenomena. Firstly, the fertilizers were not properly used due to insufficient soil moisture at the time of fertilizer application and secondly, soils were rich in nutrients. In tbis experiment, both seems to be true. Dr. Mankeur Fall, responsible for muiéi-locational yield trials at Bambey reported less yield from fertilized millet plots at Bambey during 1983. There is a need to carry out experimentation to find out the best method of application of urea and basa1 dose for their proper utilization under low moisture situations and feasible to farmers.

In all the three years, at higher spacing (90 x 90 cm), ear heads were longer and plant height was more than other spacings. The grain yield was significantly higher at 90 x 30 cm spacing as compared to 90 x 90 cm during 1982. However in 1984, in a drought year, the grain yield was 40% more at 90 x 90 cm spacing than at 90 x 45 cm. This could be because of reduced competition among plants for moisture.

Based on results, we can recommend that under unpredictable environmental situations, millet should be planted at 90 x 90 cm spacing in Bambey region. There was no significant interaction between genotypes and spacings, indicating thereby that all the genotypes, dwarf as well as tall should be

planted at 90 x 90 cm spacing.

7. BIGHLIGHTS AND ACHIEVEMENTS

a) ISRA millet improvement program was working mainly on d_2 dwarf material to produce the varieties for intensive agriculture for different agro-climatological zones in Senegal. ICRISAT helped in diversifying the genetic base by introduc ting large genetic material in form of germplasm internatinal and regional trials and nurseries.

b) ICRISAT developed multidisciplinary projects with ISRA scientists to develop new varieties, to improve existing varieties, to breed for resistance to diseases and pests and to develop cultural practices for optimizing grain yield production of newly developed varieties.

c) ICRISAT in Senegal developed three varieties-IBV 8001, IBV 8004, and IBMV 8401 which are grown by Senegalese farmers,

d) Fourteen synthetics and 23 hybrids are being identified baeed on 1 to 2 years testing. These genotypes require additional test for a year or two before recommending for testing in farmers fields.

e) Four hundred and one inbred lines were generated by combining local material with introductions. These lines were only partially utilized in generating synthetics and hybrids. This will serve a strong genetic base for initiating a new phase in the program. All these inbreds were evaluated for their per se performance and were characterized for agronomic traits.

f) ICRISAT is improving three varieties-Souna 3, IBV 8004, and PBMV 8401, as a short term goal to provide the improved material to farmers through national research system. The final comparison between the original and improved bulks will be made during rainy season 1985 for first two synthetics. The work on third varie ty should cont inue af ter the termination of third phase of this project.

g) From three year trials at Bambey on plant spacing and fertility, it is

concluded that under unpredictable rainfall situations as in Senegal, wider spacing (90 x 90 cm) is better than narrow spacing (90 x 45 cm) to avoid inter plant competition for limited mois ture and thereby to produce more grain yield. This experiment failed to establish the usefulness of application of fertilizers in drought years. Wider spacing is reeommended for dwarf as well as tall varieties.

h) Breeding materials generated in Senegal are being contributed ta millet breeders working in West Africa mainly through regionaf trials and exchange nurseries.

Advanced material from each program was jointly evaluated in International Pearl M;illet Zona1 Adaptation Trial. . Based on several years testing, it can be concluded that the material bred in Niger performed well in Senegal and the material bred in Sudan is least adapted to Senegaiese conditions. This is mainly because of smaller heads, susceptible to diseases, and poor seed set.

i) The material developed in Senegal was found useful in northern Mali, Nigeria, and Cameroon. The seed of IBV 8001 and IBV 8004 were sent to Mali and IBV 8301 to Cameroon for large scale demonstrations.

j) ICRISAT program in Senegal also collaborate with the Institute of Sahel in contributing material to their regional trial. Two synthetic varieties IBV 8001 and IBV 8004 were contributed in 1982. These varieties performed very well in CILSS tria1 and selected for testing in farmers fields in Mali. Senegalese farmers are already growing these varieties. Two varieites-IBMV 8406 and IBMV 8413 are being contributed for a tria1 in 1985. Enough seed will be left with ISRA seed service for another 4 to 5 year trials.

8. BENEFITS

a> Three high yielding and disease resistant varieties developed by ICRISAT/ISRA cooperative program for different millet growing regions of Senegal are actually grown by Senegalese farmers and thereby increasing agricultural production of the country. If 50% of total millet acreage

(total 0.95 m ha) is covered with new varieties, farmers will be able to produce additional 50,000 to 100,000 tons of millet per year or 'an additions1 income of 5 to 10 milliards CFA **(US $, 10 to 20 million)** per year.

b) Several newly developed varieties are in pipe line. These varie t ies require additional tes ting for few years before their superiority established over the existing ones.

c) ICRISAT has provided i.mproved genetic material and the research techniques to produce still hi.gh yielding varieties for the future.

d) ICRISAT/Senegal helped in identifying scientists for training at ICRISAT Center with a view to strengthen the national agricultural system and to enhance their research capabilities to more effectively use genetic material , screen the material against drought and diseases,

e) Thirty-one technicians have participated in training program at ICRISAT Center and definitely strengthened in part the capabilities of national research sys tem.

f) ICRISAT also provides logistic support to national agricultural research system in terms of conducting yield trials, establishing disease nursery, and in the multiplication of seed of varieties of pearl millet.

9. FUTURE OUTLOOK

1 propose that in future there should be two different breeding programs:

a> For the drier zone, there is a need to develop short cycle varieties (65 to 70 days to maturity) with an ability to stand drought at early stages of the crop growth. The varieties such as IBV 8004, IVS 5454 and 60 days synthetics should be crossed with local germplasm from drier zone and the selection should be made at several locations in drier zones for drought resistance, tillering ability, earliness, and ear head length. The lines should be selected from the 401 inbreds already developed by our program, the GAM material, and the new introductions made from similar

millet growing areas in Western Africa.

b) For the central and south central zones of Senegal, the varieties of 90 to 95 days cycle with medium plant height (200 to 220 cm> and dwarf plant height (140 to 160 cm) should be developed.

For medium plant heieht:

The existing synthetics, and hybrids will be evaluated in multilocational yield trials during rainy season 1985. Few should be selected for large scale testing in farmers fields from rainy season 1986.

The improved versions of Souna 3 and IBV 8004 will be compared with their original bulks during rainy season 1985. If the superioriky of improved versions (C_3 cycle) are established over existing ones. Efforts should be made to replace old Souna 3 and IBV 8004 with improved ones,

Four hundred and one inbreds and 132 F_3 progenies will be evaluated for their per se performance during rainy season 1985. The lines should be selected to generate medium tall as well as dwarf synthetics,

The best lines from our genetic stocks, GAM program, and new introductions should be made to generate mediurn tall synthetics.

Little efforts should be made to develop male-sterile lines and hybrids for central southern region of Senegal.

For dwarf plant height:

The d_2 dwarf varieties like IBMV 8401 and PS 90-2 could be an answer for intensive agriculture in south central zone where rainfall is enough in most of the years for growing pearl millet. IBMV 8401 requires an improvement for grain size and resistance to smut and drought. PS90-2 had small heads. IBMV 8401 is being improved by limited backcrossing. Efforts should continue.

To develop a productive d_2 dwarf variety, strong efforts should be made by combining all d_2 dwarf sources as IBMV 8401, 3/4 ExBornu, 3/4 Souna, 3/4 Sanio, GAM 73, GAM 75, G73K-77, IBV 7815, GAM d_2 dwarf popualations and any other agronomically superior dwarf line into a composite, A single composite should be improved initially by S_1 selections for 2 to 3 cycles and then by limited backcrossing for specific characters.

I observed in Darou and Sinthu Malene, that the farmers liked very much

IBMV 8401 for its dwarf stature and high productivity. Senegal had aeen leading country in the production of d2 dwarf material and I strongly feel that the efforts should continue.

10. REVIEWS ATTENDED

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11. WORKSHOPS ATTENDED

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CILSS Regiona l Meeting on Pearl ;Millet Improvement. Banjul, Gambia. March 1983.

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13. LINK TO NATIONAL PROGRAM

a> Multidisciplinary projects were developed involving several scientists such as:

Millet Breeder: (Dr. A. T. Ndoye)	Excellent contacts were established in terms of joint planing, conducting, and evaluation of yield trials, exchanga of genetic materials and informations.
Millet Physiologist: (Miss F. Diop)	Joint experiments were conducted to find out optimum spacing and fertilizer dose for newly developed varieties.
Millet Pathologist: (Dr. D. F. Mbaye)	Breeding for resistance to diaeaees.
Entomologist: (Dr. R. T. Gahukar)	Screening of advanced genotypes against pests.
Agronomis t (Dr. C. Dancette)	Evaluated our genotypes for their usefulness in intercropping, double cropping, and relay cropping experiments.
Food Technologist: (Dr. H. Mbengue)	Jointly evaluated the advanced material for the preparation of local foods such as couscous.

b) Established excellent relationship with the responsbiles of seed service ISRA (Mr. R. Guegan, S. Manga, and Masalia) and of multilocational trials and demonstrations in farmers fields (Mr. Mankeur Fall and C. Pochtier).

c) Established working contacts" with service semencier national and extension services such as SODEVA through ISRA.

d) The field days were arranged every year to explain the progress we have made. Both scientists and administrators were invited.

14. TRAINING OF LOCAL STAFF AND PERSONNEL

Miss Helen Joly:	Worked for 6 months at Bambey. Conduc ted an experiment on interspecific crosses towards her degree (doctor troisieme cycle).

Five technicians of ISRA working with ICRISAT were trained by me.

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Annex 1

List of Research Projects

Project Number	Title
M-l (77) WAP (SN)	Diversification of genetic base
H-2 (81) WAP (SN)	Improvement of synthetics adapted for rainfed conditions
M-3 (80) WAP (SN)	National yield trials
M-4 (81) WAP (SN)	Breeding for diseases and pests resistance
M-5 (82) WAP (SN)	Development of male sterile lines and hybrids for local adaptability
M-6 (78) WAP (SN)	Regional trials and nurseries
N-7 (77) WAP (SN)	International trials and nurseries
M-8 (82) W A P (SN)	The development of agronomic practices for optimizing yields of new varieties under rainfed conditions.

Table 1. List of International and Regional trials and nurseries conducted in Senegal from 1977 to 1984

YEAR	Trial name/material	Entries	Origin of trials
1977	Serere Composite 1	214	ICRISAT Center, India
	Super Serere Composite	214	ICRISAT Center, India
	Intl. Pearl Millet Adaptation Trial	21	ICRISAT Center, India
	Introductions	200	ICRISAT Center, India
1978	New Early Composite	214	ICRISAT Center, India
	D_2 Composite	214	PCRISAT Center, India
	Super Serere Composite	214	ICRISAT Center, India
	Pearl Millet Synthetics Trial (PMST)	25	ICRISAT Center, India
	Exptal. Varieties Trial (EVT)	25	ICRISAT Center, India
	Pearl Millet Hybrid Trial (PMHT)	25	ICRISAT Center, India
	IPMAT4	21	ICRISAT Center, India
	Intl. Millet Zonal Adaptation Trial	7	Africa
1979	D_2 Composite	214	ICRISAT Center, India
	Late Composite	214	ICRISAT Center, India
	EVT	25	ICRISAT Center, India
	Elite Varieties Trial (ELVT)	32	ICRISAT Center, India
	PMST	25	ICRISAT Center, India
	PMHT	25	ICRISAT Center, India
	IPMAT5	21	ICRISAT Center, India
	Pearl Millet Exchange Nursery (PMXN)	10	Africa
	IMZAT	7	Africa
1980	IMZAT	25	Africa
	PMXN	26	Africa
	Samaru Disease Resistant Nursery	18	Nigeria
	IPMAT 6	21	ICRISAT Center, India
	Best Population Progenies Trial	82	ICRISAT Center, India
	PMST	20	ICRISAT Center, India

Continued

	D_2 dwarf Varieties Trial (DVT)	10		ICRISAT Center, India
	F_1 crosses	50		ICRISAT Center, India
	F_2 populations	10		ICRISAT Center, India
	Hybrids and Male Steriles	84		ICRISAT Center, India
	Uniform progeny nursery (UPN)	100		ICRISAT Center, India
	Population progenies	51'		ICRISAT Center, India
1981	IMZAT	16		Africa
	PMXN	43		Africa
	IPMAT7	21		ICRISAT Center, India
	ELVT	20		ICRISAT Center, India
	DVT	30		ICRISAT Center, India
	PMST	25		ICRISAT Center, India
	Initial PMST-2	25		ICRISAT Center, India
	UPN	100		ICRISAT Center, India
	F_1 crosses (African x African)	120		ICRISAT Center, India
1982	IMZAT	14		Africa
	PMXN	72		Africa
	Niger Multilocational Tria1	10		Niger
	D_2-Dwarf Varieties Nursery	25		ICRISAT Center, India
1983	IMZAT	16		Africa
	PMXN	50		Africa
	Striga Nursery	45		Burkina Fasso
	Various segregating progenies	83		ICRISAT Center, India
	Male Steriles	17	pairs	ICRISAT Center, India
1984	IMZAT	16		Africa
	PMXN	75		Africa
	Variability and Competition Tria1	12		ICRISAT Center, India
	Male Sterile and Maintainer Lines	54		Kansas State University

Table 2. **Performance data for selected entries of the elite varieties trial at Bambey (1979 to 1981)**

S. No.	Entry	Grain yield (kg/ha) 1979	1980	1981
1	ICH 226	1607	--	--
2	ICH 241	1481	--	--
3	SC_1 7034	1367	--	--
4	ICH 154	1358	--	--
5	IVS 5454	1326	--	--
6	ICMS 7818	1257	--	--
7	ICMS 7703	1209	--	949
a	SSC-H76	1190	--	--
9	ICH 165	729	2738*	1174
10	WC a220	--	2520	--
11	IVS 8206	--	2420	--
12	ICH 383	--	2414	--
13	LC 7053	967	2333	--
14	SC-1-P78	--	2289	--
15	WC-B77	752	2271	--
16	WC 8129	--	2244	--
17	IVS-P78	--	--	1947
18	MBH 110	--	--	1518
19	ICH 220	--	--	1454
20	ICH 418	--	--	1351
21	WC-C75	--	--	1163
22	NELC-H79	--	--	1123
23	ICH 415	--	--	1057
	Check = Souna 3	1507	2189	1521
	Total entries	32	32	20
	Grand mean	966	2080	1041
	SE ±	234	195	261
	cv %	40.0	18.7	49.2

*Significantly superior from local check at 0.05 level of significance.

Table 3. Performance data on grain yield (kg/ha) for selected entries of IPMAT at Bambep (1975 to 1981)

NO.	Entry	1975	1976	1977	1978	1979	1980[a]	1981
1	ICH 45	4188	--	--	--	--	--	--
2	ICH 11	4034	--	--	--	--	--	--
3	Ex Bornu	3791	--	--	2672	--	--	--
4	ICH 5	3703	--	--	--	--	--	--
5	ICH 13	--	2508	--	--	--	--	--
6	BK 560	--	2474	--	--	--	--	--
7	WC-C75	--	2253	2897	--	480	1947	1444
8	ICH 107	--	2232	1820	--	--	--	--
9	ICH 266	--	1964	--	--	--	--	--
10	ICH 108	--	--	1938	--	--	--	--
11	BD 111	--	--	1838	--	--	--	--
12	ICH 118	--	--	1835	--	--	--	--
13	ICH 165	--	--	--	2972	1062	2461	2239
14	IVS-A75	--	--	--	2521	--	--	--
15	ICH 154	--	--	--	2468	--	--	--
16	PSB 8	--	--	--	--	822	--	--
17	ICMS 7815	--	--	--	--	755	1877	--
18	IVS 5454	--	--	--	--	692	2148	--
19	ICH 162	--	--	--	--	--	2647	--
20	ICH 211	--	--	--	--	--	2521	--
21	ICH 220	--	--	--	--	230	2497	2343
22	ICMS 7845	--	--	--	--	--	2397	--
23	NELC-H79	--	--	--	--	--	--	2064
24	WC-A78	--	--	--	--	--	--	1994
	Souna 3 (check)	3990	2 100	1720	2643	1670	2127	2373
	Grand Mean	3227	1785	1447	2022	552	2081	1772
	SE ±	284	264	373	210	82	138	164
	CV%	15.2	25.6	44.6	18.0	25.8	19.9	27.8
	No. of entries	14	80	21	21	21	21	21

[a]Mean based over three locations--Nioro, Bambey, and Louga.

4. Performance of IMZAT test entries for grain yield averaged over three locations (Nioro, Bambey, and Louga) during 1980 to 1984

Table

S. No.	Entry	1984[a] kg/ha	1984[a] Rank	1983 kg/ha	1983 Rank	1982 kg/ha	1982 Rank	1981 kg/ha	1981 Rank	1980[b] kg/ha	1980[b] Rank
1	IKMV 8201	1538	10	545	12	--	--	--	--	--	--
2	IKMV 8101	1615	4	606	10	--	--	--	--	--	--
3	IBMV 8301	1558	9	568	11	--	--			--	--
4	IBMV 8302	1302	13	739	1	--	--	--	--	--	--
5	IBMV 8401	1162	14	--	--	--	--	--	--	--	--
6	INMV 8210	1796	1	640	8	3473	9	--	--	--	--
7	INMV 8212	1582	8	655	7	3454	10			--	--
8	INMV 8220	1790	2	694	5	--	--	--	--	--	--
9	INMV 8240	1661	3	--	--	--	--	--	--	--	--
10	ITMV 8301	1458	11	--	--	--	--	--	--	--	--
11	ITMV 8303	1457	12		--	--	--			--	--
12	ITMV 8304	1596	6	--	--	--	--	--	--	--	--
13	ITMV 8305	1594	7	--	--	--	--	--	--	--	--
14	Souna 3	1080	15	699	4	4055	1	1834	2	2081	1
15	IBV 8001	1609	5		--	--	--	1547	8	--	--
16	Farmers local	666	16	691	6	3894	3	1956	1	--	--
17	ITMV 8002	--	--	725	2	3786	4	1541	10	1854	9
18	Nigerian Comp.	--		438	14	3638	7	1659	6	1552	17
19	IBV 8004	--	--		--	3658	5	1795	4	--	--
20	ITMV 8004	--	--	--	--	3651	6	1796	3	1812	10
21	KDMC		--		--	3402	1.2	3.420	12	--	--
22	CIVT 2	--	--		--	3907	2	1407	14	1534	18
	Entries	16		16		14		16		25	
	Mean	1466		602		3501		1542		1661	
	SE±	119		76		166		135		166	

[a] Mean based only on two locations--Nioro and Bambey only.
[b] Mean based only on two locations-Bambey and Louga only.

Table 5. Performance of INSAT test entries for five characters averaged over three locations (Nioro, Bambey, and Louga) during rainy seasons of 1983[a] and 1984[b].

S. No.	Entry	Days to 50% bloom		Plant height (cm)		Eead length (cm)		Downy mildew (%)		Smut (%)	
		1984	1983	1984	1983	1984	1983	1984	1983	1984	1983
1.	IKMV 8201	52.4	61.3	236	199	33.6	33.2	4.6	4.8	6.0	10.9
2.	IKMV 8101	50.5	62.9	243	206	40.4	42.0	2.0	2.6	2.8	5.2
3.	IBMV 8301	52.2	61.9	256	189	40.8	41.3	3.7	5.2	3.8	9.7
4.	IBMV 8302	57.8	65.7	267	204	56.8	55.5	11.6	20.4	3.0	7.4
5.	IBMV 8401	56.5	--	152		51.8	--	5.9	--	5.5	--
6.	INMV 8210	51.6	62.5	234	201	36.7	38.0	2.2	3.4	4.2	3.0
7.	INMV 8212	5i.2	6i.8	233	200	36.4	39.2	2.2	2.1	3.5	4.9
8.	INMV 8220	49.2	61.9	220	201	34.2	39.5	3.6	1.6	1.8	3.9
9.	INMV 8240	52.4	--	240		40.0		2.8	--	1.8	--
10.	ITMV 8301	53.6	--	258	--	51.6		3.3	--	1.8	--
11.	ITMV 8303	53.1	--	258	--	46.3	--	2.4	--	4.0	
12.	ITMV 8304	54.4	--	252	--	33.3	--	4.3	--	11.3	--
13.	ITMV 8305	53.0	--	245	--	34.2		2.2	--	4.8	--
14.	Souna 3	59.9	62.9	264	202	53.8	54.2	14.6	17.6	4.5	5.6
15.	IBV 8001	53.2	--	252	--	36.8	--	4.2	--	6.4	--
16	Local check	60.6	66.3	266	205	52.6	50.9	12-8	17.5	19.8	6.4
	Mean (16)	53.8	63.0	242	200	42.4	42.7	5.2	7.0	5.4	6.7
	SE ±	0.5	1.0	4.3	4	1.5	2.8	0.9	1.7	1.9	1.5

[a]Results are presented only for those entries which were selected for 1984 triai.
[b]During 1984, average is based on two locations--Nioro and Bambey.

Table 6. Performance of 54 inbreds derived from crosses generated in 1977-78 off-season for seven characters averaged over two locations (Nioro and Bambey) during rainy season 1984.

S. No.	Entry	Head weight ($g/6.075m^2$) 1	Days to 50% bloom 2	Plant height (cm) 3	Ear length (cm) 4	Downy mildew (%) 5	Smut (%) 6	1000-seed weight (g) 7
1.	ICMI 80001 SN	1860	52.2	217	37.6	7.0	8.0	6.7
2.	80002	1720	53.4	218	33.0	2.6	10.7	6.5
3.	80003	1776	57.4	218	41.5	27.2	5.6	7.9
4.	80004	1960	52.5	204	37.4	6.1	3.8	7.2
5.	80005	1516	53.5	200	30.0	8.2	6.2	7.5
6.	80006	1507	54.5	197	33.8	11.4	6.5	7.3
7.	80007	1150	55.8	199	27.6	5.4	3.6	6.1
8.	80008	1443	55.5	194	36.8	9.6	6.2	6.1
9.	80009	1114	59.0	174	36.7	5.1	3.8	7.3
10.	80010	884	59.4	116	38.8	12.3	11.6	5.6
11.	80011	1210	58.7	170	33.3	17.8	23.5	5.0
12.	80012	614	58.6	123	27.5	23.5	14.6	6.0
13.	80013	1156	55.4	160	31.4	11.9	12.6	4.5
14.	80014	980	54.8	162	31.8	15.2	10.4	6.6
15.	80015	1740	53.2	206	35.3	6.2	2.5	7.1
16.	80016	600	55.0	178	30.8	4.1	5.0	6.2
17.	80017	724	63.8	178	36.8	15.2	14.2	5.7
18.	80018	1327	56.4	219	31.5	7.9	4.0	6.5
19.	80019	1407	52.6	198	32.5	18.8	3.8	5.5
20.	80020	1277	56.6	198	40.0	12.6	5.0	5.5
21.	80021	1213	61.5	197	39.8	7.1	4.6	5.0
22.	80022	1666	54.0	222	40.6	5.8	7.2	7.5
23.	80023	1486	54.6	203	39.0	4.8	22.5	7.4
24.	80024	1616	56.2	229	40.7	2.5	9.2	5.4
25.	80025	2036	56.2	213	34.0	15.2	6.0	7.6
26.	80026	1405	50.3	197	42.6	7.7	11.7	7.5
27.	80027	790	55.4	192	35.8	9.7	2.2	5.2
28.	80028	1713	56.5	236	40.6	10.8	9.8	7.2

Continued

Table 6 (Continued)

		1	2	3	4	5	6	7
29.	ICMI 80029 SN	1323	52.2	150	35.2	5.6	8.8	5.7
30.	80030	1036	52.6	139	27.8	14.2	8.8	6.3
31.	80031	1633	60.2	160	36.0	10.2	7.2	6.4
32.	80032	1657	52.0	132	37.8	5.4	5.2	6.6
33.	80033	1494	55.6	167	32.8	7.0	20.0	6.3
34.	80034	1140	50.8	144	27.8	20.9	4.5	7.5
35.	80035	700	53.3	102	27.8	26.2	12.8	5.5
36.	80036	337	65.8	142	39.8	17.9	15.8	3.9
37.	80037	624	55.8	148	40.6	42.0	11.4	6.2
38.	80038	1030	54.8	139	39.5	14.6	9.0	4.7
39.	80039	1004	51.2	156	27.8	15.4	7.7	6.8
40.	80040	1787	52.6	158	35.5	13.4	3.7	5.4
41.	80041	577	58.2	128	29.8	15.3	25.8	7.3
42.	80042	926	57.0	135	37.2	34.8	2.6	7.7
43.	80043	1974	55.7	165	34.2	5.6	3.3	5.8
44.	80044	376	64.2	96	28.0	32.9	6.2	5.2
45.	80045	630	60.0	3.48	33.2	43.4	4.2	5.9
46.	80046	530	65.4	156	35.2	21.5	2.7	2.9
47.	80047	1136	54.7	122	38.8	6.0	3.8	4.2
48.	80048	540	60.4	123	34.5	6.3	7.2	5.9
49.	80049	907	50.7	118	36.6	12.8	8.0	6.0
50.	80050	1607	55.2	3.77	36.8	9.8	17.2	7.3
51.	80051	1344	54.4	180	38.2	9.6	4.8	6.9
52.	00052	1490	55.5	208	33.5	11.0	7.0	6.4
53.	80053	1310	58.2	140	27.8	1.3	2.5	7.2
54.	80054	365	63.8	130	26.8	38.0	12.0	5.7
55.	Souna 3	2094	61.4	252	56.2	3.6	7.3	5.4
56.	IBMV 8401	1470	58.2	154	46.4	3.8	8.0	5.8
	Mean	1232	56.4	172	35.4	13.1	8.4	6.2
	SE ±	155	1.1	10	2.4	5.4	4.6	0.7

[a]Thousand seed weight based only at Bambey location.

Table 7. Performance of 48 F_4 derived F_5 progenies derived from crosses generated in 1980-81 off-season for seven characters averaged over two locations--Nioro and Bambey during rainy season 1984.

s. No.	Entry	Head weight ($g/6.075m^2$)	Days to 50 % bloom	Plant height (cm)	Ear length (cm)	Downy mildew (%)	Smut (%)	1000 seed weight[a] (g)
	1	2	3	4	5	6	7	8
1.	ICMI 84001 SN	402	64.9	158	34.9	11.8	11.6	7.1
2.	84002	620	56.6	179	**39.4**	13.4	5.5	8.6
3.	84003	815	62.8	191	35.4	10.3	9.0	6.6
4.	84004	965	64.1	218	35.9	20.4	10.0	7.0
5.	84005	690	60.6	184	34.6	25.2	16.8	5.6
6.	84006	745	62.0	206	42.0	13.0	8.2	8.1
7.	84007	1832	54.8	230	36.3	12.6	8.1	8.5
8.	84008	1300	57.5	206	33.0	8.0	10.2	8.0
9.	84009	1718	53.6	216	34.5	11.6	16.1	6.9
10.	84010	1008	61.2	213	38.9	7.3	6.6	8.7
11.	84011	1178	**59.3**	**219**	**39.9**	14.0	6.4	**9.4**
12	84012	1568	57.1	246	**39.6**	9.8	13.5	7.6
13.	84013	918	61.0	232	**34.9**	8.4	22.9	8.8
14.	84014	1460	50.2	193	42.2	8.8	19.0	8.1
15.	84015	1855	53.2	238	45.4	9.0	5.6	9.8
16.	84016	1820	56.4	248	38.3	13.0	7.8	8.8
17.	84017	1042	61.2	219	42.1	26.2	5.2	9.4
18.	84018	1472	56.2	218	**35.7**	10.0	9.2	9.7
19.	84019	1175	56.0	230	**33.6**	21.9	7.4	7.4
20.	84020	1258	49.8	224	**33.1**	**20.2**	13.6	8.8
21.	84021	1570	**56.4**	252	**40.3**	**24.0**	8.7	7.8
22.	84022	1790	**54.9**	222	**37.8**	6.6	15.5	7.7
23.	84023	1738	56.2	250	35.6	9.4	9.2	8.0
24.	84025	1565	54.6	222	**40.8**	6.2	10.2	9.1
25.	84026	1325	53.0	211	31.2	a.6	3.8	9.9
26.	84027	1568	**54.0**	199	32.5	7.5	**11.5**	9.8
27.	84028	1460	52.4	238	32.8	4.9	5.8	9.6
28.	84029	2085	54.5	256	40.9	7.0	14.2	9.0
29.	84032	1315	**55.7**	**209**	32.1	9.0	10.5	7.2
30.	84033	1442	**57.6**	248	**35.9**	6.0	**3.4**	8.0

Continued

Table 7 Continued

	1	2	3	4	5	6	7	8
31.	ICMI 84036 SN	1402	56.8	216	40.5	6.0	21.2	6.5
32.	84037	1735	57.4	222	36.8	9.2	11.6	8.1
33.	84038	1712	56.8	225	35.8	11.3	8.2	6.7
34.	84039	988	56.5	208	36.2	23.4	10.2	6.9
35.	84040	1562	55.8	230	35.6	3.0	8.9	7.5
36.	84041	1758	56.8	241	36.0	6.0	13.2	8.4
37.	84042	1388	57.4	224	33.6	21.1	6.5	7.3
38.	84043	910	61.2	214	31.6	11.6	4.5	9.5
39.	84044	1395	60.8	264	34.2	7.7	2.8	9.8
40.	84045	1630	52.6	237	45.0	22.8	9.2	10.6
41.	84046	1922	52.1	237	40.0	5.8	6.9	10.2
42.	84047	1468	52.0	210	32.9	10.4	15.5	9.8
43.	84048	1795	52.8	247	42.4	7.3	4.4	9.2
44.	84049	1590	53.2	218	39.4	9.2	11.5	7.7
45.	84050	2028	54.0	222	30.7	5.3	3.6	7.7
46.	84051	1680	54.0	232	34.7	6.0	11.0	9.0
47.	84052	1712	54.8	238	36.2	9.8	5.5	10.2
48.	84053	1508	51.0	226	33.9	27.7	10.3	10.8
49.	Souna 3 (check)	1765	60.4	236	50.0	22.2	15.2	8.4
	Mean	1421	56.4	223	37.0	12.1	9.8	8.4
	SE ±	185	1.0	8.8	2.3	4.0	4.1	0.8

[a]Average over replications at Bambey.

Performance of 94 F_4 derived F_5 progenies (derived from crosses generated between Senegalese vs non-Senegalese material in 1981-82 off-season) at Bambey during rainy season 1984.

S. NO.	Entry	Head weight ($g/6.075m^2$)	Days to 50% bloom	Plant height (cm)	Ear length (cm)	Downy mildew (%)
	1	2	3	4	5	6
1.	ICMI 84054 SN	327	68.7	142	25.3	26.0
2.	84055	347	62.7	143	18.3	11.7
3.	84056	467	57.7	187	31.7	21.7
4.	84057	580	60.3	187	41.3	0.0
5.	84058	93	77.3	117	26.0	2.3
6.	84059	253	70.7	162	23.3	79.0
7.	84060	300	64.0	157	28.0	14.3
8.	84061	327	57.0	170	28.0	0.0
9.	84062	567	45.3	143	43.0	4.7
iû.	84063	600	66.3	172	26.7	2.3
11.	84064	247	65.3	178	29.7	67.3
12.	84065	693	47.3	200	37.7	6.7
13.	84066	127	69.7	133	27.0	3.3
14.	84067	253	71.0	127	21.3	4.3
15.	84068	727	60.3	183	35.3	33.7
16.	84069	400	59.0	155	35.3	0.0
17.	84070	173	72.0	138	25.0	0.0
18.	84071	140	68.3	150	34.7	44.0
19.	84072	87	75.7	120	28.0	16.7
20.	84073	180	69.7	122	20.0	2.7
21.	84074	133	67.7	128	15.0	0.0
22,	84075	100	82.3	133	15.0	0.0
23.	84076	227	72.3	148	29.7	30.7
24.	84077	280	52.0	150	20.3	7.0
25.	84078	467	62.7	147	29.3	3.3
26.	84079	a	a	a	a	92.3
27,	84080	107	72.3	150	27.7	0.0
28.	84081	287	71.3	162	26.3	4.7
29.	84082	540	57.8	185	25.7	0.0
30.	84083	493	64.0	132	26.7	14.7

Continued

Table 6 Continued

	1	2	3	4	5	6
31.	ICMI 84084 SN	110	76.0	142	26.7	4.7
32.	84085	273	68.0	173	28.0	0.0
33.	84086	307	55.7	165	37.0	2.3
34.	84087	360	71.0	168	31.0	11.3
35.	84088	420	57.7	153	26.7	16.0
36.	84089	293	54.7	160	28.3	0.0
37.	84090	213	76.3	187	37.3	21.7
38.	84091	353	66.0	198	49.0	0.0
39.	84092	227	71.3	145	32.7	9.0
40.	84093	207	56.7	152	28.0	0.0
41.	84094	347	66.3	182	31.0	7.0
42.	84095	420	68.0	177	37.0	2.3
43.	84096	427	52.3	172	31.3	16.0
44.	84097	340	72.7	153	29.0	4.3
45.	84098	600	55.3	177	36.0	24.3
46.	84099	487	67.3	155	33.7	6.7
47.	84100	820	59.3	183	28.0	4.7
48.	84101	120	72.3	130	18.3	13.3
49.	84102	340	45.7	183	33.3	15.3
50.	84103	213	78.0	130	28.7	0.0
51.	84104	70	88.0	150	31.0	88.7
52.	84105	240	79.0	130	21.7	5.0
53.	84106	333	64.7	150	30.0	0.0
54.	84107	360	54.3	170	31.3	2.3
55.	84108	407	57.7	175	22.3	7.0
56.	84109	227	73.3	172	25.0	0.0
57.	84110	360	70.7	192	32.7	2.3
58.	84111	240	70.3	173	36.0	29.0
59.	84112	613	54.3	195	34.0	13.3
60.	84113	133	65.0	130	20.3	0.0

Continued

Table 8 Continued

	1	2	3	4	5	6
61.	ICMI 84114 SN	400	67.0	170	32.3	4.7
62.	84115	360	57.0	128	19.0	6.7
63.	84116	67	78.0	145	24.7	25.3
64.	84117	313	63.3	180	22.7	18.7
65.	84118	200	82.3	157	24.3	0.0
66.	84119	300	77.0	153	25.7	0.0
67.	84120	440	53.0	147	24.3	24.3
68.	84121	287	70.7	160	29.3	14.7
69.	84122	427	67.7	173	29.7	11.0
70.	84123	180	77.3	183	33.0	9.0
71.	84124	a	a	a	a	3.3
72.	84125	33	76.7	118	31.0	33.3
73.	84126	140	77.0	148	24.7	15.5
74.	84127	20	88.3	130	25.0	25.0
75.	84128	320	77.0	162	29.7	2.3
76.	84129	a	a	a	a	a
77.	84130	740	60.3	198	32.7	0.0
78.	84131	267	68.0	132	27.7	2.3
79.	84132	300	a	182	35.3	0.0
80.	84133	300	66.0	140	35.0	3.3
81.	84134	127	a	130	21.3	0.0
82.	84135	220	50.0	132	20.3	11.0
83.	84136	287	66.3	167	32.7	17.7
84.	84137	213	72.7	145	21.7	11.3
85.	84138	480	63.7	170	23.3	51.0
86.	84139	153	69.3	147	28.7	4.3
87.	84140	293	60.3	152	27.3	26.7
88.	84141	427	64.7	153	24.7	13.3
89.	84142	260	54.3	138	26.0	3.3
90.	84143	127	65.3	160	28.7	0.0

Continued

Table 8 Continued

	1	2	3	4	5	6
91.	ICMI 84144 SN	513	56.3	188	36.3	12.0
92.	84145	267	64.7	128	36.3	9.3
93.	84146	293	59.7	160	17.7	44.3
94.	84147	47	[a]	120	22.0	43.0
95.	84024	560	52.7	178	42.0	0.0
96.	84030	520	44.0	155	24.0	0.7
97.	8403 1	620	46.0	165	19.7	0.0
98.	84034	340	67.7	177	29.3	0.0
99.	64035	613	51.7	192	38.7	2.3
100	Souna 3 (check)	847	60.3	185	42.0	28.0
	Mean	327	65.2	158	28.9	12.9
	SE ±	93	4.5	14	3.8	7.5

[a]Not recorded due to poor germination or heavy downy mildew incidence.
From 95 to 99, these are F_4 derived F_5 progenies from crosses generated in 1980-81 off-season.

Table 9. **Performance of 200 F_4 progenies derived from crosses generated between Senegalese vs non-Senegalese material (1981-82 off-season) for five characters averaged over three locations (Nioro, Bambey and Louga) during rainy season 1984.**

S. No.	Entry	Head weight ($g/6.075m^2$)	Days to 50% bloom	Plant height (cm)	Ear length (cm)	Downy mildew (%)
1.	ICMI 84148 SN	293	60.3	195	37.7	75.0
2.	84149	540	66.7	174	39.7	18.2
3.	84150	380	67.0	213	39.7	9.1
4.	84151	713	65.0	218	37.7	11.1
5.	84152	847	63.3	195	33.7	29.2
6.	84153	627	68.0	195	37.0	4.6
7.	84154	1353	59.0	209	44.7	7.7
8.	84155	1087	61.3	194	38.0	7.7
9.	84156	450	65.7	223	31.7	10.0
10.	84157	873	64.7	220	41.3	0.0
11.	Souna 3	1887	63.0	229	49.0	28.2
12.	84158	847	59.7	182	33.0	7.7
13.	84159	867	62.3	199	42.0	0.0
14.	84160	1027	60.7	197	45.0	11.6
15.	84161	820	60.0	200	43.0	61.9
16.	84162	1073	58.3	198	39.0	12.5
17,	84163	500	59.7	177	34.7	15.0
18,	84164	1313	61.3	225	50.0	11.6
19.	84105	680	64.3	172	46.0	20.8
20.	84166	320	64.7	178	38.7	48.2
21.	84167	1967	56.3	227	49.7	11.6
22.	IBMV 8401	1153	60.0	151	47.0	7.5
23.	84168	1160	59" 0	210	37.7	19.2
24.	84169	527	65.0	224	44.3	8.4
25.	84170	887	61.3	194	39.0	10.8
26.	843.71	580	62.3	185	35.0	37.8
27.	84172	387	61.3	164	34.7	20.0
28.	84173	920	60.3	201	35.7	8.4
29.	84174	1013	57.7	162	35.0	7.2
30.	84175	507	67.7	199	37.3	0.0
31.	84176	613	69.7	164	34.7	0.0
32.	84177	1387	00.7	23:	48.7	3.8
33.	Souna 3	1800	61.7	240	56.0	

Table 9 Continued

			1	2	3	4	5
34.	ICMI	84178 SN	367	63.0	152	33.7	71.6
35.		84179	633	65.0	241	44.7	11.6
36.		84180	1340	58.0	192	44.0	8.4
37.		84181	1160	55.7	201	32.7	3.8
38.		84182	673	67.0	207	32.0	0.0
39.		84183	813	59.3	204	34.3	3.4
40.		84184	420	71.0	173	30.7	9.1
41.		84185	1080	71.3	196	35.3	7.7
42.		84186	600	63.3	165	32.0	4.1
43.		84187	640	69.0	179	32.3	9.1
44.		IBMV 8401	1200	63.0	155	47.7	8.4
45.		84188	813	65.7	201	33.0	8.4
46.		84189	1053	69.3	204	34.7	10.5
47.		84190	553	63.0	217	36.3	3.8
48.		84191	867	58.3	205	39.3	7.7
49.		84192	1940	59.7	235	42.7	0.0
50.		84193	147	66.3	166	32.0	13.6
51.		84194	1927	58.0	239	40.7	19.2
52.		84195	453	68.0	192	34.0	0.0
53.		84196	1653	57.0	207	31.7	3.4
54.		84197	280	64.7	190	39' 0	3.8
55.		Souna 3	1693	60.7	241	55.3	11.7
56.		84198	847	58.0	233	35.3	15.0
57.		84199	433	72.7	221	43.7	0.0
58.		84200	907	65.7	222	40.7	0.0
59.		84201	447	55.7	205	44.3	3.8
60.		84202	487	64.3	184	36.0	0.0
61.		84203	680	65.0	180	32.0	0.0
62.		84204	700	66.3	191	37.7	16.6
63.		84205	920	62.3	177	32.7	4.2
64.		84206	300	68.3	180	46.7	7.7
65.		84207	2220	52.7	224	34.3	0.0
66.		IBMV 8401	1093	59.7	133	54.0	7.7

Continued

Table 9 Continued

		1	2	3	4	5
67.	ICMI 84208 SN	640	64.7	204	35.0	7.7
68.	84209	1347	62.3	221	45.7	11.6
69.	84210	673	66.3	192	41.7	3.4
70.	84211	673	61.7	178	42.7	37.5
71.	84212	913	63.3	222	39.3	8.4
72.	84213	367	69.0	177	42.0	20.0
73.	84214	507	69.7	200	49.7	31.6
74.	84215	1053	63.3	232	57.3	0.0
75.	84216	740	62.0	183	32.7	0.0
76.	84217	667	64.3	197	42.0	21.0
77.	Souna 3	1647	60.7	230	56.3	18.2
78.	84218	787	57.7	198	46.3	3.8
79.	84219	253	69.7	160	35.7	16.6
80.	84220	660	53.0	182	36.7	7.7
81.	84221	640	67.0	213	45.3	15.1
82.	84222	633	67.7	158	26.3	0.0
83.	84223	900	72.7	228	44.7	0.0
84.	84224	1027	63.7	178	44.0	0.0
85.	84225	1107	69.7	177	42.0	0.0
86.	84226	450	68.7	136	34.0	0.0
87.	84227	640	67.7	175	41.0	0.0
88.	IBMV 8401	973	68.7	148	43.3	15.4
89.	84228	280	68.3	121	43.0	5.6
90.	84229	887	63.3	181	43.7	3.8
91.	84230	780	66.7	172	40.0	11.0
92.	84231	473	65.0	161	43.7	0.0
93.	84232	653	66.0	131	39.0	3.8
94.	84233	1500	62.0	238	52.0	3.4
95.	84234	793	64.0	192	42.3	41.8
96.	84235	653	62.7	198	36.0	11.6
97.	84236	913	64.3	197	34.7	8.4
98.	84237	513	60.3	109	36.7	7.7
99.	Souna 3	2147	61.3	2 2 1	56.7	15.4

Continued

Table 9 Continued

		1	2	3	4	5
100.	ICMI 84238 SN	207	65.7	150	35.7	7.7
101.	84239	640	65.7	188	39.7	20.8
102.	84240	720	65.7	207	43.7	4.2
103.	84241	587	62.7	214	38.0	0.0
104.	84242	687	65.0	168	27.3	0.0
105.	84243	1240	56.7	197	32.0	28.4
106.	84244	1100	60.0	171	34.7	0.0
107.	84245	860	56.7	207	39.0	0.0
108.	84246	500	65.0	170	37.3	16.6
109.	84247	613	61.7	207	40.0	15.8
110.	IBMV 8401	1420	58.0	138	48.0	3.4
111.	84248	1220	59.0	181	32.7	11.6
112.	84249	733	58.7	186	36.3	4.2
113.	84250	453	63.7	174	32.7	17.8
114.	84251	940	61.0	137	32.0	0.0
115.	84252	607	68.3	109	31.7	7.7
116.	84253	380	68.0	132	32.7	3.4
117.	84254	580	62.0	135	31.0	8.4
118.	84255	1340	56.0	202	42.0	3.8
119.	84256	567	57.7	181	34.3	4.2
120.	84257	767	56.3	204	35.7	25.6
121.	Souna 3	2100	62.0	245	61.7	15.0
122.	84258	840	65.3	218	36.3	4.2
123.	84259	1167	62.0	222	38.0	0.0
124.	84260	1333	59.7	232	55.7	15.4
125.	84261	1047	59.0	217	38.0	20.8
126.	84262	960	58.7	201	31.3	0.0
127.	84263	1093	56.7	208	41.3	7.7
128.	84264	507	66.3	229	45.0	15.0
129,	84265	373	69.0	175	28.0	11.7
130.	84266	600	65.0	207	31.0	9.1
131.	84267	660	63.3	211	36.3	7.9
132.	IBMV 8401	1380	58.7	3.49,	50.3	3.8

Continued

Table 9 Continued

			1	2	3	4	5
133.	ICMI	84268 SN	753	64.3	179	30.7	0.0
134.		84269	880	62.0	199	29.3	9.1
135.		84270	940	59.3	198	37.3	10.5
136.		8427 1	920	61.3	199	30.3	0.0
137.		84272	887	65.3	182	32.3	36.6
138.		84273	640	66.3	180	34.0	7.7
139.		84274	953	63.3	192	35.3	11.9
140.		84275	1033	55.7	157	30.0	7.7
141.		84276	1433	57.7	171	35.3	0.0
142.		a4277	627	65.7	188	35.7	25.4
143.		Souna 3	1920	60.7	219	44.3	21.7
144.		84278	1370	'57.0	154	30.0	7.7
145.		84279	307	67.0	149	33.3	4.2
146.		84280	953	68.0	178	46.0	0.0
147.		84281	1080	63.0	210	36.3	16.0
148.		84282	1927	55.7	221	46.7	3.4
149.		84283	927	66.7	211	39.3	8.4
150.		84284	867	66.3	157	27.0	0.0
151.		84285	853	62.0	170	35.3	3.8
152.		84286	800	63.3	187	35.0	4.2
153.		84287	847	60.0	196	50.3	5.0
154.		IBMV 8401	1507	57.3	3.65	58.7	7.7
155.		84288	980	61.3	164	35.3	25.6
156.		84289	1007	59.3	186	36.0	3.4
157.		84290	1273	57.0	196	36.7	3.8
158.		84291	493	68.0	179	33.7	3.8
159.		84292	400	67.0	191	38.3	7.7
160.		84293	1153	54.7	163	38.3	4.2
161.		84294	1073	56.7	187	37.7	14.4
162.		84295	f307	59.3	206	36.3	0.0
163.		84296	327	73.3	185	40.0	45.8
164.		84297	433	68.7	130	36.7	15.8
165.		Souna 3	1427	67.3	224	49.3	18.4

Continued

Table 9 continued

		1	2	3	4	5
166.	ICMI 84298 SN	180	73.3	88	28.0	16.6
167.	84299	1027	60.0	200	45.7	3.8
168.	84300	733	63.0	177	45.7	3.8
169.	84301	833	63.0	222	54.0	28.2
170.	84302	913	62.3	209	49.3	0.0
171.	84303	440	66.7	158	38.0	3.8
172.	84304	787	55.7	207	43.0	12.5
173.	84305	1047	64.0	223	47.0	7.5
174.	84306	600	65.3	191	45.3	16.6
175.	84307	687	63.0	201	44.3	12.5
176.	IBMV 8401	1353	57.3	147	52.3	7.7
177.	84308	560	66.3	190	43.7	4.2
178.	84309	733	62.3	186	40.0	18.8
179.	84310	547	64.7	228	45.0	3.8
180.	84311	1080	59.0	218	40.7	3.8
181.	84312	407	67.3	175	34.3	11.2
182.	84313	520	63.0	215	47.0	100.0
183.	84314	960	57.3	158	32.7	15.4
184.	84315	1313	56.3	207	42.7	3.4
185.	84316	987	60.7	222	49.3	0.0
186.	84317	400	65.3	188	37.0	54.6
187.	Souna 3	1733	62.7	239	54.0	29.2
188.	84318	427	64.0	172	25.7	6.2
189.	84319	993	55.7	lb5	32.7	3.8
190.	84320	913	58.7	216	38.7	48.8
191.	84321	913	55.7	217	36.0	21.0
192.	84322	1320	58.3	191	37.7	0.0
193.	84323	993	61.7	293	39.3	16.6
194.	84324	107	72.0	145	36.0	37.5
195.	84325	1527	59.7	167	35.0	9.1
196.	84326	470	58.7	175	42.0	14.3
197.	84327	323	67.7	171	42.3	10.5
198.	IMBV 8401	1487	58.7	148	49.3	0.0

Continued

Table 9 Continued

		1	2	3	4	5
199.	ICMI 84328 SN	393	66.0	160	29.7	0.0
200.	84329	920	65.7	190	42.7	0.0
201.	84330	1027	53.7	175	32.3	10.0
202.	84331	180	70.7	174	34.0	0.0
203.	84332	700	63.0	174	34.7	0.0
204.	84333	1160	62.0	212	38.3	16.0
205.	84334	390	68.0	211	46.0	29.8
206.	84335	1347	59.3	217	50.3	0.0
207.	84336	347	65.3	174	36.7	43.4
208.	84337	793	64.0	191	46.3	38.2
209.	Souna 3	1720	62.0	239	52.7	15.8
210.	84338	773	58.0	212	44.3	21.4
211.	84339	860	62.3	183	37.0	12.5
212.	84340	1047	65.3	187	42.3	8.4
213.	84341	890	63.0	185	35.0	16.6
214.	84343	1113	63.3	219	39.7	12.4
215.	84344	340	69.7	156	33.7	4.6
216.	84345	860	63.0	193	38.7	3.8
217.	84346	1067	66.0	199	39.7	7.7
218.	84247	807	65.3	199	35.0	4.6
219,	84248	693	71.3	197	37.0	3.4
220,	IBMV 8401	1060	61.0	137	50.7	9.1
	Souna 3 (10)	1807	62.9	233	53.5	18.1
	IBMV 8401 (10)	3.207	60.5	150	50.1	7.1
	Mean (220)	872	62.9	190	39.6	11.6
	SE±	225	2.6	12	3.2	6.8

[a] Downy mildew based on two locations--Nioro and Bambey only.

Table 10. Performance data on adjusted grain yield in individual environment for 16 entries of Senegal Begionai trial eonducted during rainy season 1980.

S. NO.	Entry	Nioro		Bambey		Louga		Mean	
		Kg/ha	Rank	Kg/ha	Rank	Kg/ha	Rank	Kg/ha	Rank
1.	IBV 8001	2848	3	2276	2	1698	2	2274	2
2.	IBV 8002	2622	7	1590	10	1297	11	1836	6
3.	IBV 8003	2569	8	1393	10	1325	9	1762	10
4.	IBV 8004	3064	1	2370	1	1902	1	2445	1
5.	IBV 7815	2464	9	1623	5	1434	7	1840	5
6.	D_2-BB78	2122	i4	i022	16	1117	12	1470	15
7.	ICMS 7819	2861	2	1728	3	1216	13	1935	3
8.	SC 1 7034	1948	16	1227	12	1078	15	1418	16
9.	IVS 5454	2091	15	1583	7	1620	3	1765	9
10.	IVS-S78	2802	5	1473	8	1203	14	1826	7
11.	D_2-BB 78 (I)	2824	4	1218	13	1489	5	1844	4
12.	ICMS 7703	2325	11	1167	15	1561	4	1684	12
13.	3/4 Ex Bornu	2748	6	1275	11	1302	10	1775	8
14.	WC-C 75	2342	10	1457	9	1002	16	1600	13
15.	BK-560	2145	12	1172	14	1461	6	1593	14
16.	Souna 3	2123	13	1666	4	1409	8	1733	11
	Mean	2494	--	1515	--	1391	--	1800	--
	SE ±	145	--	180	--	165	--	95	--
	CV%	13.0	--	26.5	--	26.5	--	20.4	--
	Efficiency over RBD	101.8	--	117.5	--	151.8	--	--	--

Table 11. Mean squares for seven characters in joint yield trial conducted at four locations during 1981 to 1984.

Source of variation	D.P.	Grain yield (q/ha)	Days to 50% bloom	Plant height (cm)	Ear length (cm)	Downy mildew (%)	D.F.	Smut (%)	D.F.	1000 seed weight (g)
Genotype (G)	9	138	627	118137	6278	621	9	220	9	19.8
Environment (E)	15	6193	2104	59701	238	737	14	2873	12	115.5
G x E	131	31	36	1135	41	60	123	70	105	0.9
Location (L)	3	8316	4261	164120	335	1138	3	1074	3	57.3
Year (Y)	3	13486	3050	97969	147	883	3	3283	3	109.2
L x Y	9	3054	1069	12140	237	555	8	3394	6	147.8
G x L	27	28	50	3248	68	**93**	**27**	**63**	**27**	**1.2**
G x Y	26	16^{ns}	38	1073	62	66	26	108	26	0.8*
G x L x Y	78	37	30	425	26	46	70	59	52	0.7*
Pooled Error	700	13.6	10.7	255	16.4	16	660	26	570	0.46
CV%	--	23.5	6.1	7.8	9.5	98	--	55	--	9.38

^{ns}, * Non-significant, significant at 0.05 level of signifirance, respectively. Rest of the mean squares are significant at 0.01 level of significance when compared with pooled error.

Table 17. Mean performance of 10 entries in multilocational yield trials during last four years (1981 to 1984) over 16 environments and 96 replications in Senegal.

Entry	Grain yield (q/ha) Mean	b	S^2di	Mean[a]	Days to 50% bloom	Plant height (cm)	Ear length (cm)	1000 seed[b] weight (g)	Downy mildew (%)	Smut[c] (%)
ICRISAT										
IBV 8001	17.595'"	1.06	0.77	15.68**	53.4	228	35.7	7 75	2.8	8.0
IBV 8004	16.77""	1.02	2.88""	14.69""	52.5	225	38.3	7.64	2.8	9.2
ICMS 7819	15.53	1.03	0.44	13.31	52.5	201	31.4	7.80	2.7	8.9
IBMV 8401[a]	13.02	1.02	1.82	13.02	57.4	148	48.9	6.64	2.2	10.5
GAM										
H7-66	16.95**	1.06	1.04	15.08**	52.6	214	46.2	7.67	1.9	8.8
PS90-2	15.62	0.97	-0.28	13.75	53.3	144	32.7	7.16	3.7	12.5
H9-127	15.53	0.94	1.17	13.72	53.8	172	44.8	7.24	1.8	10.0
H24-38	14.91	0.90	7.02**	i3.24	49.8	206	40.9	7.20	4.â	9.6
Checks										
Souna 3	15.05	0.93	8.57**	13.01	57.6	241	53.7	6.97	8.9	7.0
Farmers local	15.34	1.06	5.77**	13.10	57.5	244	53.8	6.24	8.2	7.8
Mean	15.70	1.00	29.20	13.86	53.9	204	42.5	7.24	4.0	9.2
SE±	0.38	--	--	0.41	0.33	1.6	0.41	0.08	0.4	0.5
LSD at 5%	1.04	--	--	1.14	0.92	4.5	1.15	0.21	1.1	1.5

**For grain yield, mean significantly superior to checks and S^2 di (deviation from regression) from zero at 0.01 level of significance : b's (regression values) are not significantly different from one.

a Mean based on 3 years data (1982 to 1984). IBMV 8401 was not included in trial during 1981.

b Thousand seed weight based on 13 environments for all entries except IBMV 8401 (10 environments),

c Smut incidence based on 15 environments for all entries except IBMV 8401 (12 environments).

Table 15. Mean performance of ten genotypes for grain yield production averaged over four years at four locations, and averaged over eight highest, and eight lowest yielding environments.

Entry	Nioro		Darou		Bambey		Louga		Average[a]		Average[b]	
	kg/ha	Rank	kg/ha	Rank	kg/ha	Rank	kg/ha	Rank	kg/ha	Rank	kg/ha	Rank
IBV 8001	2172	1	1666**	2	1977	2	886**	1	2525**	1	805**	4
IBV 8004	2041	5	1975**	1	1916	4	770	2	2329	3	829**	1
ICMS 7819	2007	7	1814*	4	1842	5	548	9	2436	5	670	8
IBMV 8401[c]	1602	10	1418	8	1672	9	516	10	2080	10	525	10
H7-66	2157	2	1814"	4	2045*	1	764	3	2541**	2	849	2
PS90-2	2119	3	1733	5	1745	7	651	8	2356	6	768	6
H9-127	2091	4	1624	7	1815	6	682	6	2265	8	841	3
H24-38	1953	9	1395	9	1921	3	696	5	2193	9	790	5
Souna 3	2015	6	1621	6	1715	8	671	7	22 73	7	738	7
Farmers local	1940	8	1861**	3	1634	10	701	4	2438	4	630	9
Mean	2027	--	1733	--	1%32	--	694	--	2403	--	767	--
SE±	77	--	61	--	98	--	56	--	61	--	45	--
LSD at 5%	214	--	170	--	272	--	156	--	169	--	124	--
CV%	18.6	--	17.4	--	26.2	--	39.7	--	17.6	--	40.4	--

*, ** Significantly superior from Souna 3 at 0.05 and 0.01 levels of significance, respectively.

[a], [b] Average based on eight highest and lowest yielding environments, respectively. For IBV 8401 average is based over six environments,

[c] Average based on three years (IBMV 8401 not included in 1981 trial).

Table 14. Performance of preliminary synthetics trial entries for grain yield at two locations (Nioro and Bambey) and for six characters averaged over two locations duriag rainy season 1984.

S. No.	Entry	Grain yield (kg/ha) Nioro	Bambey	Mean	Days to 50% bloom	Plant height (cm)	Ear length (cm)	Downy mildev (%)	Smut (%)	1000-seed weight (g)
1.	IBMV 8403	1656	628	1142	51.8	212	41.5	7.9	6.5	7.30
2.	IBMV 8406	1606	664	1135	49.6	196	35.4	4.6	3.2	7.77
3	IBMV 8404	1407	612	1009	50.8	200	40.2	8.9	3.6	7.42
4.	IBMV 8402	1207	772	990	53.4	204	37.6	6.6	7.8	7.21
5.	IBMV 8405	1267	638	953	54.4	204	35.9	11.4	3.6	6.64
6.	IBMV 8413	1326	517	922	57.4	206	37.6	10.2	4.2	7.22
7.	IBMV 8416	1058	636	847	55.4	219	35.0	8.4	6.1	6.70
8	IBMV 8412	1158	522	840	58.1	180	34.8	14.0	6.4	6.53
9.	IBMV 8419	1142	510	826	62.0	211	38.4	9.2	5.5	7.08
10.	IBMV 8414	1130	515	822	58.0	188	37.5	12.0	6.5	7.44
11.	IBMV 8415	981	601	791	58.2	222	42.2	16.6	6.9	6.61
12.	IBMV 8409	1059	415	737	57.4	175	38.2	10.7	5.2	6.74
13.	Souna 3	812	539	676	62.5	196	47.3	15.4	9.7	5.91
14.	IBMV 8408	822	516	669	55.4	190	32.4	12.0	8.1	6.96
15.	IBMV 8401	701	625	663	57.5	144	49.0	11.3	7.9	6.55
16.	IBMV 8417	864	436	650	62.8	202	35.1	9.8	8.3	6.92
17.	IBMV 8411	975	320	648	58.5	183	33.4	7.5	7.5	6.28
18.	IBMV 8407	904	387	646	55.2	177	31.3	12.0	4.4	5.92
19.	IBMV 8410	827	382	604	62.9	178	34.4	10.2	6.5	6.36
20.	IBMV 8418	315	233	274	70.2	208	40.7	17.6	19.7	5.48
	Mean	1061	524	792	57.6	195	37.6	10.8	6.9	6.80
	SE±	168	70	106	1.5	8	2.0	2.4	1.9	0.26
	CV%	38.7	26.8							

Note: The mean for Nioro and Bambey is based over 6 and 4 replications, respectively.

Performance of single cross hybride for six characters at Bambey during rainy season 1983.

S. No.	Entry	Grain yield (kg/ha)	Days to 50% bloom	Plant height (cm)	Ear length (cm)	Downy mildew (%)	Smut (%)
1.	111 A x IBMI 8206	1327	79.6	166	43.6	4.3	60
2.	x IBMI 8207	1338	79.2	149	39.4	0.4	45
3.	x IBMI 8108	1562*	71.2	160	45.6	2.6	42
4.	x PS 90-2	1577*	73.0	152	40.6	8.4	64
5.	81 A x IBMI 8206	1439*	72.4	155	30.8	1.4	52
6.	x IBMI 8207	1664*	74.2	159	31.7	1.9	84
7.	x IBMI 8108	1865*	68.0	126	33.6	0.4	49
a.	x PS 90-2	707	73.0	120	29.6	0.0	84
9.	1100 A x IBMI 8206	1191	74.8	167	39.0	0.0	52
10.	x IBMI 8207	878	78.8	146	34.1	2.4	75
11.	x IBMI 8108	1072	75.8	134	40.8	0.4	70
12.	x PS 90-2	852	76.0	113	34.3	0.0	79
13.	1369 A x IBMI 8206	1125	76.2	171	38.2	0.0	35
14.	x IBMI 8207	805	79.2	152	33.7	4.1	57
15.	x IBMI 8108	1121	75.4	120	37.4	1.5	52
16.	x PS 90-2	547	78.4	112	35.2	0.8	74
17.	1399 A x IBMI 8206	1210	75.6	172	37.2	2.2	67
18.	x IBMI 8207	1067	79.0	162	37.6	2.5	49
19.	x IBMI 8107	1225	73.0	132	41.2	2.1	59
20.	x PS 90.2	1205	77.8	124	39.1	4.0	83
21.	1417 A x IBMI 8206	959	75.2	158	35.1	5.1	53
22.	x IBMI 8207	1048	79.6	154	32.4	2.7	
23.	x IBMI 8108	997	75.6	119	40.8	2.1	87
24,	X PS 90-2	1270	78.4	126	41.9	6.4	79
25.	1644 A x IBMI 8206	1303*	76.6	165	37.3	2.9	39
26.	x IBMI 8207	1091	77.6	158	37.2	0.5	71
27.	x IBMI 8108	883	79.6	119	40.9	0.4	88
28.	x PS 90-2	816	77.6	113	36.1	0.7	86
29.	IBV 8004	1039	75.4	173	39.0	3.9	25
30.	Souna 3	1271	77.2	203	55.8	14.8	27
	Mean	1148	76.1	146	38.0	2.6	61
	SE±	231	1.8	4.9	1.1	1.2	9
	CV%	44.9	5.4	7.5	6.5	103	34

*Entries selected for retesting in rainy season 1984.

Table Lb. Performance of single cross hybrids for grain yield in individual location during rainy season 1984;

S. No.	Entry	Pedigree	Nioro		Bambey		Mean	
			kg/ha	Rank	kg/ha	Rank	kg/ha	Rank
1.	ICMH 8401	IBMI 8108 x Souna 3	2397	11	1502	9	1949	12
2.	ICMH 8402	IBMI 8108 x IBMV 8401	1893	21	1127	22	1510	23
* 3.	ICMH 8403	111 A x IBMI 8108	2785	4	1924	3	2354	3
* 4.	ICMH 8404	111 A x PS 90 - 2	2588	9	1680	6	2134	7
5.	ICMH 8405	111 A x IBMV 8401	2293	13	1626	7	1960	11
6.	ICMH 8406	111 A x Souna 3	2593	8	1459	10	2026	9
* 7.	ICMH 8407	111 A x F_4 195	3278	2	1872	4	2575	1
8.	ICMH 8408	111 A x F_4 166	2650	6	1390	13	2020	10
* 9.	ICMH 8409	111 A x IBV 8001	2662	5	1513	8	2088	8
10.	ICMH 8410	111 A x IBMI 8108-31-z	2251	15	1386	14	1818	14
* 11.	ICMH 8411	111 A x IBMI 8108-58-3	2594	7	2129	1	2362	4
* 12.	ICMH 8412	81 A x IBMI 8206	2908	3	1730	5	2319	5
* 13.	ICMH 8413	81 A x IBMI 8207	3424	1	1400	12	2412	2
* 14.	ICMH 8414	81 A x IBMI 8108	2466	10	2070	2	2268	6
15.	ICMH 8415	1417 A x PS 90-2	1569	24	870	25	1220	25
16.	ICMH 8416	1417 A x IBMI 8108-21-z	2283	14	1189	20	1736	14
17.	ICMH 8417	1417 A x IBMI 8108-31-z	2240	16	1223	19	1732	16
* 18.	ICMH 8418	1644 A x IBMI 8206	2370	12	1312	16	1841	15
19.	ICMH 8419	1644 A x Souna 3	1821	22	1321	15	1571	21
20.	ICMH 8420	1644 A x IBV 8001	2007	20	1425	11	1716	17
21,	ICMH 8421	1644 A x IBV 8004	1552	25	1026	24	1289	24
22.	ICMH 8422	1055 A x IBMI 8108-30-l	2150	18	1039	23	1594	20
23,	ICMH 8423	1055 A x IBMI 8108-31-1	2126	17	1227	18	1696	18
* 24.	ICMH 8424	1423 A x IBMI 8108-21-2	1743	23	1310	17	1526	22
25.	Souna 3	--	2068	19	1129	21	1598	19
	Mean		2332		1435		1884	--
	SE±		271		197		168	--
	CV%		28.5	--	34.0	--	30.8	--

*Entries selected for retesting in 1985.

Table 17. Performance of single cross hybrids for sevea characters averaged over two locations during rainy season 1984.

S. No.	Entry	Days to 50% bloom	Plant height (cm)	Ear length (cm)	Downy mildew (%)	Smut (%)	1000 seed weight (g)	No. of heads/ $21.06m^2$
1.	ICMH 8401	57.1	256	48.7	7.2	12.8	5.8	120
2.	ICMH 8402	57.0	154	45.3	**4.9**	**9.5**	6.0	112
3.	ICMH 8403	53.2	208	47.4	11.2	14.6	6.5	166
4.	ICMH 8404	51.1	194	45.7	11.0	27.3	6.8	184
5.	ICMH 8405	54.6	206	53.9	11.6	21.1	6.0	166
6.	ICMH 8406	52.6	**219**	52.4	6.3	17.9	5.1	160
7.	ICMH 8407	52.6	214	42.2	5.1	29.2	6.8	216
8.	ICMH 8408	56.6	239	44.8	5.8	10.4	5.5	152
9.	ICMH 8409	53.6	214	45.4	6.0	23.8	6.2	164
10.	ICMH 84 10	55.0	201	47.9	7.6	15.4	5.4	154
11.	ICMH 8411	52.1	210	48.8	11.0	**15.9**	5.8	150
12.	ICMH 8412	49.9	217	35.0	4.2	20.8	8.8	174
13.	ICMH 8413	52.4	217	35.8	5.2	19.2	8.1	187
14.	ICMH 8414	51.0	152	36.0	9.6	22.6	7.0	202
15.	ICMH 8415	56.2	137	38.8	13.4	28.0	5.4	142
16.	ICMH 8416	56.4	156	42.5	12.6	10.2	7.8	139
17.	ICMH 8417	58.3	153	41.4	11.0	15.5	6.4	132
18.	ICMH 8418	55.4	211	39.0	12.2	10.2	6.4	119
19.	ICMH 8419	59.8	218	44.8	18.5	13.4	5.6	90
20.	ICMH 8420	57.9	202	36.4	8.0	35.2	6.9	110
21.	ICMH 8421	59.4	214	40.4	13.1	25.8	5.9	90
22.	ICMH 8422	58.0	138	37.0	3.9	8.4	5.9	114
23.	ICMH 8423	55.9	142	39.8	10.8	10.7	5.8	130
24.	ICMH 8424	57.0	152	41.2	11.8	8.0	4.9	110
25.	Souna 3	61.7	264	61.6	12.5	12.8	5.9	84
	Mean	55.4	196	43.7	9.4	17.6	6.3	143
	SE±	0.6	5.7	1.3	1.8	3.9	0.3	9.6

Table 16. Performance data of synthetic populations progenies selected for three cycles from 1982 to 1984 rainy seasons for six characters averaged over one to three locations.

Year	Population	Number of progenies	Grain yield[a] (kg/ha) Mean	S. D. (%)[b]	Days to 50% bloom	Plant height (cm)	Ear length (cm)	Downy mildew (%)	Smut (%)
	Souna 3								
1982	All prog.	364	2791	--	54.2	252	53.1	12.2	0.2
	Sel. prog.	36	3858	38.2	54.0	255	51.5	4.9	0.6
1983	All prog.	261	826	--	64.4	198	54.0	24.2	11.7
	Sel. prog.	36	917	11.0	64.2	198	54.1	13.3	11.6
1984	All prog.	432	1916	--	60.4	267	58.9	17.3	7.3
	Sel. prog.	36	2488	29.8	59.5	269	58.9	8.8	6.5
	IBV 8004								
1982	All prog.	357	2500	--	48.6	226	32.0	2.6	3.0
	Sel. prog.	40	3553	42.1	48.8	237	34.2	2.2	1.2
1983	All prog.	400	833	--	61.0	183	37.0	5.7	12.7
	Sel. prog.	42	1128	35.4	61.0	192	39.9	3.2	12.9
1984	All prog.	432	1115	--	60.0	205	38.9	1.5	10.5
	Sel. prog.	36	1501	34.6	58.8	210	40.6	0.4	9.6

[a] Grain yield = head weight x 0.7.
[b] S. D. = Selection differential.

Note: 1982: Planted only at Bambey.
1983: Planted at Nioro, Bambey, Louga and disease nursery. For downy mildew, average bas& over Nioro, Bambey and disease nursery.
1984: Souna 3 based on Nioro and Bambey; and downy mildew on Nioro, Bambey and disease nursery. IBV 8004 based on Bambey and Louga; and downy mildew on Bambey and disease nursery.

Table 19. Performance of synthetics improved for two cycles in Senegal for grain yield at Nioro and Bambey locations and for six characters averaged over locations during rainy season 1984.

S. No.	Pedigree	Grain yield (kg/ha)			Days to 50% bloom	Plant height (cm)	Ear length (cm)	Downy mildew (%)	Smut (%)	1000 seed weight (g)
		Nioro	Bambey	Mean						
1.	Souna 3 C_0	1155	1122	1138	61.5	254	57.0	16.4	11.2	6.2
2.	Souna 3 (S_1) C_1	1409	1313	1361	61.4	259	58.4	14.2	11.3	6.0
3.	Sounda 3 (HS) C_2	1301	1174	1237	60.6	255	57.4	9.8	10.4	5.8
4.	IBV 8004 C_0	1660	1449	1555	53.2	242	43.3	4.8	8.8	7.2
5.	IBV 8004 (S_1) C_1	1611	1559	1585	52.7	244	40.6	5.4	7.0	7.2
6.	IBV 8004 (HS) C_2	1801	1410	1606	54.2	252	43.0	6.0	6.0	7.0
7.	IBV 8001 C_0	1485	1328	1406	55.8	248	39.4	6.0	5.6	6.9
8.	IBV 8001 (M) C_2	1902	1292	1597	54.4	250	43.6	7.2	6.7	6.8
9.	IBV 8004 (M) C_1	1620	1457	1538	54.0	254	43.5	6.9	7.4	6.7
10.	IBMV 8401	968	1169	1068	57.4	147	50.4	9.2	19.3	5.4
	Mean	1491	1327	1409	56.5	240	47.6	8.6	9.4	6.5
	SE±	137	104	86	0.5	5	1.4	1.2	1.8	0.2
	CV%	25.9	22.2							

Table 20. Mean squares of Genotype x Fertilizer x Spacing trial for five characters planted in split'split plot design during rainy seasons of 1982 to 3.984 at Bambey.

Source of variation	D.P.	Grain yield (q/ha)	Days to 50% bloom	Plant height (cm)	Ear length (cm)	Downy mildew (%)
	1	2	3	4	5	6
Year 1982						
Replications (R)	5	74.18	1.89	320.7	6.68	23.0
Fertilizer (F)	1	85.66*	0.69	798.1	16.67	26.4
Error a	5	12.87	0.54	146.0	30.06	19.0
Spacing (S)	2	76.08	0.51	412.0	46.15"	200.6**
S * F	2	14.70	0.63	16.1	1.30	17.1
Error b	20	22.00	1.14	130.9	10.64	27.4
Genotype (G)	3	1350.20**	496.93**	34084.3**	4226.20**	871.3**
F * G	3	22.65	0.55	29.2	2.48	20.9
S * G	6	15.26	1.27	58.2	7.86	165.2**
F * S * G	6	8.93	0.98	284.2*	6.66	25.9
Error c	90	17.34	0.61	124.3	5.44	23.1
Year 1983						
R	5	10.51	38.15	901.2	121.78	33.0
G	3	40.26	413.39**	47604.7**	906.25**	880.9**
Error a	15	32.24	41.49	350.9	15.50	15.5
F	2	0.19	2.02	157.6	0.19	42.8**
G * F	6	2.12	18.35	81.9	7.32	44.1**
Esror b	40	16.07	20.21	179.7	8.65	6.7
S	1	0.98	28.44*	2917.8**	258.67**	123.4**
S * G	3	6.66	7.17	184.5	7.45	27.4**
S * F	2	1.35	8.22	49.9	6,05	1.7
F * S * G	6	0.91	1.33	15.3	8"05	1.0
Error C	60	4.41	6.53	119.9	7.38	3.7

Continued

Table 15 Continued

	1	2	3	4	5	6
Year 1984						
R	7	193.73	10.58	1891.1	47.91	34.2
F	2	4.56	4.13	215.8	2.85	7.6
Error a	14	32.43	7.58	634.5	68.30	14.8
S	1	352.03**	48.00"	1957.1	851.35""	620.3**
S * F	2	46.11	5.83	83.2	0.92	8.8
Error b	21	16.03	6.45	775.0	21.02	31.6
G	3	113.94**	513.79**	10917.4**	927.76-k-k	886.2**
F * G	6	2.11	3.47	290.1	10.10	15.5
S * G	3	10.19	2.88	28.3	15.88	124.1**
F * S * G	6	7.64	3.14	371.8	13.26	5.6
Error c	126	7.84	2.87	338.1	17.11	17.0

*, ** Indicates mean squares significantly different from corresponding error terms at the 0.05 and 0.01 levels of significance, respectively.

Table 21. Mean performance of different genotypes, spacings, and fertilities for three characters planted in split split plot design[a] at Bambey.

Entry	Grain yield (kg/ha)			Days to 50% bloom			Plant height (cm)		
	1982	1983	1984	1982	1983	1984	1982	1983	1984
Genotypes (a)									
Souna 3	3435	1059	650	50.6	70.7	59.2	291	204	236
H7-66	2987	1217	904	43.7	64.4	53.2	246	179	208
IBV 8004	3025	1009	958	44.5	66.2	51.7	260	189	222
IVS 5454	1993	--	--	42.0	--	--	215	--	--
IBMV 8401	--	979	686	--	71.4	54.4	--	121	130
SE±	69	95	40	0.13	1.07	0.24	1.9	3.1	2.6
Spacings (b)									
90 x 90 cm	2746	1058	935	45.3	07.7	55.i	257	178	202
90 x 60 cm	2838	--	--	45.1	--		253	--	--
90 x 30 cm	2995	--	--	45.1	--		251	--	--
90 x 45 cm	--	1074	664	--	68.6	54.1	--	169	196
SE±	67	25	41	0.15	0.30	0.26	1.6	1.3	2.8
Fertility (c)									
0:0:0	--	1066	779	--	68.4	54.9	--	175	197
33:21:21	2783	1072	830	45.3	68.0	54.4	251	173	201
61:31:31	2937	1059	790	45.1	68.0	54.6	256	172	199
SE±	42	60	71	0.09	0.65	0.34	1.4	1.9	3.1
Triai Mean	2860	1066	799	45.2	68.2	54.6	253	173	199
CV% (a)	14.6	53.3	35.0	1.7	9.4	3.1	4.4	10.8	9.2
CV% (b)	16.4	19.7	50.1	2.4	3.7	4.6	4.5	6.3	14.0
CV% (c)	12.5	37.6	71.3	1.6	6.6	5.0	4.8	7.7	12.6

[a] During 1982 and 1984, main plots, sub plots, and sub-sub plots were fertility levels, spacings, and genotypes, respectively. In 1983 main plots were genotypes, sub plots, fertility leveis, and sub-sub plots were spacings,

Table 22. Mean performance of different genotypes, spacings, and fertilities for ear length and downy mildew incidence planted in split split plot design[a] at Bambey.

Entry	Ear length (cm)			Downy mildew (%)		
	1982	1983	1984	1982	1983	1984
Genotypes (a)						
Souna 3	54.9	50.7	47.9	1.8	10.9	13.2
H7-66	46.1	45.2	43.8	0.5	1.0	4.3
IBV 8004	39.4	38.4	37.2	0.2	1.8	4.1
IVS 5454	29.2	--	--	10.6	--	--
IBMV 8401	--	45.6	43.3	--	0.4	5.8
SE±	0.39	0.66	0.60	0.80	0.66	0.60
Spacings (b)						
90 x 90 cm	42.5	46.3	45.2	5.4	4.5	a.7
90 x 60 cm	43.3	--	--	3.0	--	--
90 x 30 cm	41.4	--	--	1.4	--	--
90 x 45 cm	--	43.6	41.0	--	2.6	5.1
SE±	0.47	0.32	0.47	0.76	0.23	0.57
Fertility						
0:0:0	--	45.0	43.1	--	2.9	6.7
33:21:21	42.1	45.0	43.2	2.8	3.2	6.6
61:31:31	42.8	44.9	42.8	3.7	4.6	7.3
SE±	0.65	0.42	1.03	0.51	0.37	0.48
Tria1 Mean	42.4	45.0	43.1	3.2	3.3	6.9
CV%(a)	5.5	8.7	9.6	150.2	112.5	59.8
CV%(b)	7.7	6.0	10.6	163.6	55.0	81.5
cv% (c)	12.9	6.5	19.2	136.2	74.0	55.8

[a] During 1982 and 1984, main plots, sub plots, and sub-sub plots were fertility levels, spacings, and genotypes, respectfvely. In 1983, main plots were genotypes, sub plots-fertility levels and sub-sub plots were spacings.

1980 to 1984.

Period		Nioro					Darou			
		80	81	82	83	84	81	82	83	84
June	1-10	12.5		1.6		76.7	0.3	3.5		38.0
	11-20	0.5			58.2	19.0		4.4	4.0	32.5
	21-30		31.6	5.4	6.6	90.3	32.0			115.9
July	1-10	16.7	78.7	4.0	38.2	41.6	56.6	21.8	15.0	9.3
	11-20	15.5	42.7	100.6	102.1	21.3	17.9	93.2	49.4	34.2
	21-31	52.0	111.6	44.2	0.1	8.5	78.7	104.0		36.4
Aug.	1-10	139.5	95.1	55.6	45.8	76.6	130.4	62.7	94.0	50.1
	11-20	26.5	69.5	47.4	5.7	19.3	67.6	53.8	18.6	17.5
	21-31	50.5	107.1	117.5	18.4	15.5	153.8	221.3	60.8	26.0
Sept.	l-10	148.1	78.5	22.8	80.8	8.0	31.9	54.6	45.3	0.8
	11-20	18.0	81.7	59.7	9.7	64.8	50.7	90.1	10.4	165.0
	21-30	i5.5	14.1	20.3	19.4	51.8		8.5	55.8	75.5
oct.	l-10	23.0	20.8	34.0	6.0	42.9	0.7	4.0	25.8	14.3
	11-20	1.8	45.8	27.9	16.1		54.8	23.0	10.7	
	21-31						17.0			
TOTAL		520.1	777.2	541.5	407.1	536.3	692.4	744.9	389.8	615.5

Period		Bambey					Louga				
		80	81	82	83	84	80	81	82	83	84
June	1-10					4.6	0.2				0.5
	11-20		25.		75.0	81.5				5.4	7.2
	21-30					32.0		5.4	1.6		
July	l-10	0.1	25.0		6.0	12.0	5.1	6.3		2.3	
	11-20	0.2	3.0	89.6	1.5	3.7			50.5	1.1	3.3
	21-31	8.6	73.3	79.5	40.0	70.7	44.1	40.9	37.2		9.3
Aug.	l-10	130.6	99.7	17.0		62.0	103.6	75.2	24.9		63.3
	11-20	78.4	17.1	49.0	8.5	49.0	1.6	2.2	27.1	19.9	
	21-31	35.1	36.9	110.8	67.6	7.0	16.9	52.7	26.4	106.3	0.5
Sept.	1-10	103.9	27.1	63.8	15.5	41.3	51.8	35.8	11.3	1.5	21.7
	11-20	18.5	177.9	21.1	18.0	60.2	1.5	31.2	25.5	7.6	50.7
	21-30	3.2	7.3	6.8	83.8	22.4	29.3			1.3	6.4
oct.	1-10	23.4	0.9			11.4	19.4		8.6	0.8	10.4
	il-20		2.6	14.6					1.7	0.3	
	21-31		8.0								
TOTAL		402.0	503.8	452.2	315.9	457.8	273.5	249.3	214.8	145.7	173.3