REPUBLIQUE DU SENEGAL
MINISTERE DE L'ENSEIGNEMENT SUPERIEUR
ET DE LA RECHERCHE SCIENTIFIQUE

SECRETARIAT D'ETAT A LA
RECHERCHE SCIENTIFIQUE
ET TECHNIQUE

THIRD FAO / SIDA SEMINAR
ON FIELD FOOD CROPS
IN AFRICA AND THE NEAR EAST

NAIROBI, KENYA JUNE 6 - JUNE 24, 1982

PEARL MILLET IMPROVEMENT IN SENEGAL

S. C. GUPTA, A. T. NDOYE AND D. J. ANDREWS

MAY 1982

CENTRE NATIONAL DE RECHERCHES AGRONOMIQUES
DE BAMBEY

INSTITUT SENEGALAIS DE RECHERCHES AGRICOLES

PEARL MILLET IMPROVEMENT IN SENEGAL

S.C. Gupta[1], A.T. Ndoye[1] and D.J. Andrew[2]

INTRODUCTION

In Senegal, pearl millet and sorghum (0.97 mn ha) are second in importance to groundnut (1.05 mn ha), bath in terms of surface area covered and production. Among the cereals, pearl millet is the most predominant crop in the north and centcr regions of the country where rainfall is low and erratic. In the south where rains are camparatively favourable, the principal crops are sorghum, maize and rice. Two major types (Souna and Sanio) of pearl millet are grown in this country. Over 85 per cent of pearl millet grown is of Souna type (75 to 90 days to naturity) and the rest is Sanio (120 - 150 days). Souna is grown in the north and center regions of the country while Sanio in the southern part o f the country.

The major problems in pearl millet production are low grain yiold, drought, diseases, poor harvest index, insects and occasionally Striga. The rapid progress in genetic improvement is possible because of the wide range of genetic variability available in the germplasm and the ease of crossing utilizing the protogynous nature of the crop.

Earlier attempts were mado to improve the traditional varieties. The systematic efforts were made since 1970 after establishing the millet improvement team (Groupe d'amélioration du mil - GAM) with the objectiva of developing high yielding uarietias with yield stability for intensive agriculture . The ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) startod its progrnm in 197'7 with a prime objective of strengthening the national program mainly through diversifying the genetic base.

---

1 - Pearl Millet Breeders, ICRISAT and ISRA Programs respectively, C.N.R.A. Bambey, B.P. 51, Senegal.

2 - Leader, Pearl Millet Improvement Program, ICRISAT Patancheru Center, Andhra Pradesh 502324, India.

EARLIER WORK

The Millet improvement program at "Centre National de Recherche* Agronomiques (C.N.R.A.)", Bambey started as early as in 1937 by producing inbred lines by pedigree selection in two local populations. By 1949, CNRA developed 213 lines of millet. Through celfing, the lines lost the vigour of the populations, The variety 165 gave 20 per cent mare grain yield than the lines dorivcd from this population, Twenty eight selections were made by 1959 based an yield per plant and other characters associated with yield per plant. These were tested between 1959 and 1961. There was an imgrovement in homogeneity but the yield levels were equal to local. Only five late selections were conserved for future utilization. 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 inbrcd lines. Moreover complex maes selaction is efficient on local unimprovsd populations, This method allows improvement upto 30 %. Presently the hybrids obtained by cross breeding between a population and an inbred line have given upta 147 % of the local population as best results. Favourablc results have baen obtained by mixed cultivation of several populations in the same seed hole.

In 1965, three recurrent selection programs on early millets and two on late millets were in progress.The three recurrent selections on early millets were grouped into a single synthetic . Souna 2. This synthetic was 107 and 121 % superior to local check in first and second generations of multiplication. /respectively/ The synthetics obtained from selection on late varieties gave interesting results only in first gencration of multiplication. Souna 2 was improved through top cross testing using PC 25 (Souna of Bambey Serere) and thon Souna 2 as a tester (Etasse 1969). Eight linos (106-7, 108-4, 113-3, 115-4, 134-5, 142-4, 143-4 and 148-3) extracted from Souna 2 through to cross testing were recombined in 1969 to form Souna 3. This variety was released for general cultivation in 1972,

GAM PROGRAM

In 1970, Senegal launched a multidisciplinary (genetics, physiolagy, pathology, cntomology and agronomy) program on millet improvement out of a determination to ochieva self-sufficiency in food through diversification.

1. Dwarf Varieties

In case of traditional varieties only 15-20 % of the tata.1 dry matter is converted into grain whereas in case of maize like the ZM10 variety = 44 %, and 55 % PRE short strawed rice like the native Taichung variety. This is why the program for the improvement of millet developed in Senegal since 1970 has been orientated mainly towards the improvcment of harvest index. This was achieved by croasing 29 African populations (8 from Upper Volta, 6 from Mali, 10 from Niger, 4 from Senegal nnd 1 front Chad) with three dwarf parents ($23D_2B$ and $239D_2B$ from U.S.A., and I 472 from India).

In 1973,. the synthetic GAM 73 was developed by recombining tho morphological similar progonics derived from a cross I 472 X HK 1133. The characteristics of CAM 73 were-dwarf plant height (135 cm), longer ear head (44.5 cm), few effective tillers per plant (2.9) and high harvest index (41 %). By the middle of 1374, another synthetic . GAM 75 of completely different plant architecture was developed by recombining morphological similar 15 F_4 prgganies derived from a cross Tift $23D_2B$ X Aniata. Heads were more but much shorter of GAM 75 than GAM 73, to facilitate threshing with machines. Stems of GAM 75 were much more thinner than thosc of plants constituting thc population GAM 73, resulting in reduced effort for tha cutting of stems and ploughing at harvest (Bilquez 1974).

These two synthetics gave good results undcr irrigoted and highly fertilized environments but could not compete with traditional varieties under farmers situation. Theso synthetics also had poor threshing percentage (55 %) as compared to other millet varieties (70 %).

2. Varieties of Different Maturity Cycles

Agroclimatic rcsearch by CNRA hns shown that the millet haviny a vegetative cycle of 90 days, con be grown with at least a 80 % chance of success each yenr in the region of Bambey - Latitude 14°30 N, average rainfall 648 mm (Dancette 1974). The chance of success becomes 42 % when grown furthcr north in the region of Louga (Latitude 15°30' N, average rainfall 481 mm) and only 26 % in tho 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 thoso grown in thc region of Podor, a vegetative cycle not exceeding G O days.

Based on above recommendations, attempts were made to produce 60, 75 cnd 90 days synthetics for different regions of the country. Based on combining ability tests, tha parents were choscn from cxisting material for creating the synthctics of different maturity cycles. Only a feu parents could bu selected to form one of the each 60 and 75 days synthetics. Several lines were identified of 90 days maturity type which were tested for thcir combining ability through top cross testing. The selected parents were crossod in diallel mating system for the better estimation of genetic parameters nnd for selecting the parents with high general combining ability effects. The parents were selected to form seven 90 days synthotics (11 GAM SYN 90, 10 GAM SYN 90, GC5, VI 80-85, 5 GAM-3/4 Souna, 5 GAM - 3/4 EB and 4 GAM 3/4 HK). During 1981-82 off-season, these synthctics were in fourth generation of random mating. The value of theso 90 days synthotics will be detorminod during coming rainyseason.

Thc dif forent generations of rnndom mating of two/early/maturing dwarf synthetics (60 and '75 days) were compareci with Souna 3 (a tall 90 days synthetic) during 19'7'7 tu 1979, Early maturing synthetics could not produce equal yiold as compared to Souna 3 oven in the environmonts for which they were developed. A strong rolationship was found between grain yield and longth of cycle (C. Lambert 1980, personal communication).

3. Genetic Pools and Constitution of Composites

In 1977, the dwarf lines available were rcgroupod to form the gcnctic pools - three pools based on maturity PS 60, PS 75 and PS 90, one (PS AC) basod on architecture C and one (PSM) based on variable cycle and structure. Theso pools were allowed for two generations of random mating. To this group, three dwarf populations - 3/4 Haino Kairi, 3/4 Ex Bornu, and 3/4 Souna and two synthotics - GAM 73 and GAM 75 were also added. It was obssrvod that the pool of 90 days - PS 90 was quite close to one of the dworf population 3/4 Ex Bornu except for plant height and the length of leaf. In yield trials - PS 90 shawed a potentiality of high yield production with better stability. Tha grain yield obtained was Y6 % of thoee of Souna 3 and one of the S_1 soloction gave grain yield oqual to Souna 3 in multilocation testing. This selection will be mnintainod through sibbing and further testing will be carried out. Thc population os such will De improved through recurrent selection.

Five hundred fifteen S_1 progenies dcrivnd f'rom a genetic pool were tested against Sounn 3 and original genetic pool, Tho environment offect of plant height, straw weight, and ear length on groin weight have been studied by stopwise rogression analysis which will be published shortly.

Attempts would be made to form composites based on S_1 performance over environments, dorived from diverse genetic pools.

4. Creation of Inbred Linos

Two types of crosses and ono S_1 of PS 90 have beon exploited for thc creation of linos during last three years. Thoso arc :

i) Crosses between $23D_2B$ and 13 African populations,
ii) Crosses between 37 linos from GAM with 3/4 Haine Keiri, 3/4 Ex Bornu, 3/4 Souna, Nigerianand mid-late composites.

During 1979, 203 F_4 progenies were tested alongwith 3 checks - Sounn 3, NHB 3 and DM24. Sixteen F_4 progenies were retained for further testing during 1980. Four progcnios - l-R-66, H24-38, H9-127 were found equally good yielder as Souna 3 coupled with botter resistanco ta downy mildew. Thoso entries alongwith a S_2 solection from PS 90 and thc best identified material Prom ICRISRT were tested in multilocations during 1981. Thc progcny H7-66 (6.4 % superior to Souna 3) was found equally good as Sounn 3 as in 1979 and 1980 tests. Two othcr entries - PS 90-S_2 40 and H9-127 were retained for furthcr testing. The inbrceding depression duo to selfing in new linos is being estimated.

Thc future activitics relating to thc creation of linos will bu :

- Evaluation of F_4 and F_5 progenies derivod from two typas of crosses discussed earlier.
- Improvament of progcnios themselves which have conf irmed their çuporiority ovor Souna 3 during last two years.
- Development of synthetics by rccombining selected progenies.

5. Architectural Studies

This project was started in 1979 with the following objectives :

- To compare thc characteristics of traditional variotios in comparison to variotios actually selected.
- To develop varieties from tho best populations or their descendants .
- To define polymorphisn and genetic organizations of populotions.
- To determine factors associated with high yield.
- To estimate the genetic parameters for various characters.
- To study the performance and stability of newly developed synthctics over years.

Thit project hns 106 entrios derived mainly from three sources :

i) Collection of traditional variotics from five regions of Senegal, Niger, Mali., Sudan, Upper Volta and Nigeria.

ii) Dwarf millet isolated from local populations of Senegal.

iii)The tall and dwarf millet material created at research centers.

A trial of 106 such entrios was planted from 1979 ta 1981 at Bambey, Louga and Nioro. Tho visual observations on different sites indicated that tho traditional material has high genetic divcrsity and good adaptation. T h c characteristics of ear heads were often very interesting even in highly downy mildew susceptible populations. We have observed a little smut and ergot and practically no Raghuva,

On certain populations S$_3$'s were produced which will be tested during coming season. Thc material selected will be utilitcd for the estimation of genetic parameters for various characters.

ICRISAT PROGRAM

Tho fundamental objective of ICRISAT millet improvcmont program is to increase the yield levels of millet of semi-arid farmers and to maintain it at higher level than they arc todny, To achieve this objective, multidisciplinary teams are working at ICRISAT Center, Patancheru, Indic and in six African countrics - Niger, Senegal, Mali, Upper Volta, Nigeria and Sudan. Scientists spread in different Africûn countries work in close cooperation with thc scientists in national program, regional program and tho other ICRISAT programs. Moreover, tho scientists based in country programs such as in Senegal havc three responsibilities,

National/Regional/ and International. Thc bost material identified from regional and international programs used in national program for wider testing and/or for using in breeding programs.

Tho ICRISAT program in Senegal started in 1977 with tho following objectivas :

- To develop and impravo tho varieties of 75 and 90 days to maturity in collaboration with ISRA scientists.
- To improvo grain yield production, and its stability, grain size, harvest index, resistance to diseases and maintain the head length.
- In future, depending on tho facilities availablo, tho improvements would bo made for resistances to drought, striga and insccts.

1. Divcrsification of Genotic Base - GAM x Indian

This project was started in 1977 by introducing and evaluating tho bost ICRISAT material (mainly in farm af Regional nnd International trials and nurseries) under the ecological conditions found in Senegal and subsequently by combining tho selected ICRISAT material with the selected GAM materia\ in ordor to take advantage of the genotic distance botween thoso two types of material.

During 1977 and 1 3 7 8 , F_1 hybrids were produced between GAM and ICRISAT material. These F_1 hybride were advanced by selfing.Several F_2 populations were backcrossed to GAM parent and thon advanced by selfing. Tho principal results o f the introduced material and crosses are summarized below.

Tho material introduced from ICRISAT Center, India was mainly of Indian, Nigeriûn and Ugandian origin. This material was tested for three years 1977 to 79. The Nigerian material had high yield potential coupled with botter resistance ta diseases, tha Ugandian material was early with largo head whereas the Indian introductions were highly tillering, thin stems and modium plant haight with small earheads. ICRISAT material originotcd frnm Nigeria and Uganda had botter general combining ability with 3/4 Hoino Keiri and 3/4 Ex Bornu populations,

At the cnd of thc pcdigroo soloction (F_4 nnd F_5 stage), the selected progenies and the introduced itself were utilized in following three ways :

i) For synthotics - Entries were selected based an cambining ability tost to form Pive synthctics. Two synthctics - IBV 8001 and IBV 8004 have givon good performanco in last two years multilocational tests. Besidc grain yiold, thay were shortar in hcight, earlier in flowering, higher s o e d weight and better resistance to downy mildew as comparcd ta local chack - Sauna 3. It is intorosting to note that tho constituent parents for these two synthetics were direct introductions from ICRISAT Center, India.

ii) For inbrud lines - One of thom IBV 8108 - modium plant hcight, less susceptiblo to diseases, and quito uniform has been selected for furthcr exploitation.

iii) For further crossing - 47 entrios were selected and crossed in three groups : 11 tall antrics diallel, 10 dwarf antrics diallel nnd 27 entries were crossed with three testors with tho objectivo of creating new genetic variability and to select tho lines Par developing naw synthctice. These crosses were tested during 1981 and based *on* general combining ability affect, mean grain yiold pcrf ormanco and other agronomic traits, parents were selected to form fivo synthetics. These synthotics will be tested during coming season.

Intcrcstingly the crosses anong dwarfs (140 - 190 cm plant hcight) exhibited better haterosis than the crosses amang talls. fho F_2 populations willbo advanced through podigroo selection and in advanced gonorations, thc parents will bo selected for dovaloping 75 and 90 days synthetics.

2. Diversification of Genetic Baso - Senegalese X Non Senegalese

During 1977, l a r g o amount of genetic material from ICRISAT Center was introducod and is bcing usod in first projoct - CAM x Indian. Since then several new germplasm linos were added to ICRISAT Center germplasm and breeding materials were gonorated with better rosistnncc to diseases. On the ather hand, thc progross has bean made in GAM material particularly for scod setting and resistanco ta downy mildew. To take advantage of improvod material of ICRISAT and GAM, this sacand project on the diversification of genetic baso was initiated in 1980. Unlike, the first project, largo number of selected GAM linos including local landraces are being usod in thio projuct.

Genotypes from the largo number of International and Regional trials and nurseries planted in Senegal during 1980 were selected with high yield and good level of resistance. Tho S_1 progenies Prom thesc were planted during the off-season 1980-81. Eight hundred and eighty two S_2 progenies derivcd from these were planted at Bambey and Nioro during 1981 for screening against downy mildew and smut. Thirtytwo progenies of diverse origin based on maturity, height ond bristleness were selected to use in this project.

Sixty Senegalese gonotypos were selected or collected - 12 GAM lines, 34 germplasm collections maintained by GAM, 10 linos selected fron the ORSTOM collection by ICRISAT, and 24 landraces collectad by us during 1981,

The thirty two non-senegalese best identified materials were crossed with the senegalese 60 entries during the off-season 1981-82. The F_1 hybrids will be evaluated during the coming rainy season. The material will bu advanced through modifiod pedigree selection and the progenies will be solectod to form 75 and 90 dnys synthetics.

In 1984, the first and second projects will be merged and from tho selectad material, 75 çnd 90 days composites will bo formed which will be improved through recurrent selection. By then we hope to start looking for potential restorer linos and the dovelopment of male-sterile in a suitable AP rican background.

Improvement of Synthetics

This project was startod in 1981 with tho aim of improving two aynthctics - Souna 3 and IBV 8004 thrsuyh recurrent solcction. Sauna 3 is one of the best and the only relecsod vnriety in Senegal. It is highly susceptible to downy mildew and possesses variation for several characters like stem thickness and seed size. IBV 8004 is a new synthetic devoloped by recombining Souna 3, 700516 (Nigeria), Serere 2A and Serere 14 (Uganda). It has givcn good performance during last two years in multilocational trials. IBV 8004 is highly variable because of its diverse parental constitution and needs improvement for acceptable uniformity. Attempts would ho made to improve them for resistance against diseases ond fur harvest index. First cycle of recurrent selection was initiatad during 1981-82 off-season by producing over 350 S_1's from

each of the synthetic. These S_1 progenies will bc evaluated during tho coming rainy season. The selected S_1's (40 to 50) will be recombined during 1982-83 off-seoscn. Since recurrent selection through S_1 testing requires two years ta complete a cycle, thc future improvcmcnts would bo made through half-sib testing.

4, Breeding for Disease Rosistnncc

Major diseases i n Senegal are downy mildew (Sclerospora graminicola), smut (Tolyposporium penicillariae) and ergot (Claviceps fusiformis). Occurence of these three diseases was reported in 1963 by Bouriquet. We have observed downy mildew and smut almost every where in farmers fields during 1980 nnd 81, Occurence o f ergot i s observed only o n late plantings or i n specific years.Improvement o f existing varieties and breeding material against downy mildew a n d smut i s one o f our breeding objectives.

T h i s project is being initiated in 1981 in collaboration with GAM pnthologist and breeder. Natural sources o f resistance are available and introduced i n the form of International and Regional disoaso nurseries. At pr osent, we are not able t o select t h o material ef fectively under uniformly h i g h disease pressure due to lack of artificial disease nursery. However, the selected material under natural environment i s utilized i n our breeding program.

Attempts will bc made to create o n artificial disease nursery where t h c material can be screenedf a r downy mildew as well as smut .

MULTILOCATIONAL YIELD TRIAL

As in other brcoding programs, the advanced entries arc tested i n 5 t o 6 trials at 3 to 4 locations every year. Thc entries which prove supcriority in thoso trials are tested rigorously in a Joint trial. This trial includes the host material identified by difforont breeders working in Senegal. I n the coming rainy season, few o r all entries will also bo tested b y the millet pathologist, p h y s i c l o g i s t , entomologist and agronom ist working at Bambey. E f f o r t s will be made to explore tho possibilities for cooporstion with the Food Technology I n s t i t u t e at Dakar for testing thc elite material for nutritional and cooking quality. The bcst material from this arc being advanced f o r demonstration i n Senegal and f o r regional testing.

In the first joint trial (1981), the entries includcd five progony varieties from GAM, four synthetics snd one experimental variety from ICRISAT and two chscks - Souna 3 and farmers local. Thiç trial was conducted in four locations - Louga, Bamboy, Darou and Nioro, spread over north ta south central region of Senegal.

The performance data based on mean over four locutions are presented bolow :

Joint trial - 1981

N°	Entry	Grain yield t/ha	Plant height (cm)	Ear length (cm)	50 % Bloom	Grain weight (g)	Downy mildew (%)	Smut (%)
1	IBV 8001	2.33	248	32.7	50.6	8.3	5.1	10.9
2	IBV 8004	2.30	247	37.0	51.1	7.7	5.1.	10.0
3	H7-66	2.26	228	44.4	49.4	8.1	3.3	11.2
4	ICMS 7819	2.22	226	31.5	50.7	8.6	4.5	9.8
5	LOCAL	2.20	283	56.0	54.3	6.4	12.6	5.9
6	PS90-S_2-40	2.12	146	30.2	51.1	7.3	4.0	16.4
7	SOUNA 3	2.12	274	55.1	53.4	7.4	16.1	5.8
8	H9-127	2.10	169	43.4	51	7.4	3.0	16.5
9	D_2-8878	2.02	157	37.4		7.1	5.0	19.6
10	H24-38	1.99	230	40.8	47.0	7.6	8.6	13.1
11	IBV 781.5	1.74	159	34.6	48.8	7.7	7.5	18.9
12	H4-24	1	1 73	45.5	55.9	6.5	3.8	30.2
	Grand Mean		212	40.8	50.3	7.5	6.5	12.3
	S.E. of Mean	0.08	3.0	0.7	U.3	0.1	1.3	1
	C.G. at 5 %	0.23	8.2	2.0	0.9	0.4	3.6	5.1
	C.V. %	19.6	6.9	8.6	3.2	8.1	96.9	63.1

The highest yielding entry was synthetic IBV 8001 (9.9 % superior to Souna 3), followed by IBV 8004 (8.5 %), H7 - 66 (6.4 %) and ICMS 7819 (4.7 %). All the above four entries were shorter in plant height, earlier in flowering, higher seed weight, and better resistance to downy mildew as compared to Sounu 3 and farmers variety. On the other hand, Souna 3 and farmers variety had better resistance to smut and longer ear head.

During 1980, the season started very late and was quite different from 1981, However these four entries - IBV 8004, IBV 8001, H7-66 and ICMS 7819 were 41, 31, 21 and 12 % suparior to Souna 3 in terms of grain yield production. Tho good performence of IBV 8001, IEV 8004 and H7-66 was also confirrnod by tho results obtoinod by the physiologists of CNRA. These entries starting from 1382 will be tested in a regional trio1 organized by Sahelian Institute (CILSS).

SUMMARY AND CONCLUSIONS

Tho millet improvement program at Bambey (Senegal) started as early qs in 1931 with the nim of producing imbred linos by following continued selfing in traditional varioties. In 1949, the imbrod linos derived Prom population 165 were compared with tho original population and found that the imbrod linos were 20 % less yielding than tho original population. Recurrent selection work was started in 1961 to improve the traditional varieties. This program led to the development of synthetic Souna 3 which was releasod in 19'72 for general cultivation.

Tho concept of devslcping dwarf varioties for a botter distribution of photosynthate into grain and straw than tha cxisting varieties was devaloped in late sixtios. A multidisciplinary team including breeder, physiologist, pathologist, entomologist and agronomist started in 1970 with the aim to improve grain yield production and its stability for intensive agriculture. This team crossed vorious Africnn traditional varieties with tha dwarf parents from United States of America and India to produce dwarf synthetics. By 1974, twc synthctics - GAM 73 and GAM 75 of different architecture were developed. The selected material from this project was utilized for developing 60, 75 and 90 days synthetics for different regions of the country. During 1976, tho genetic base was uivorsifiod by introducing Africnn and Indian material. Tho material is being currently used for the development of now inbred lines and composites. Thc gcnctic architecture of traditional varieties and geographie cally diverse populations is under study. Tho selected populations and newly created composites will bu improved through recurrent selection.

Tha International Crops Research Instituto for the Semi-Arid Tropics (ICRISAT) started its program in *1777* with the prime objectivo of strengthoning the national progrnm. In collaboration with I.S.R.A. (Institut Sénégalais de Recherches Agricoles) scientists, ICRISAT utilized the best ISRA material and local landraces in crossing with the best

material f'rom ICRISAT Regional and International programs for developing 75 and 90 days synthetics. Recently the recurrent selection program for improving two synthetics - Souna 3 and IBV 8004 and the brccding for disease resistance were initiated.

We have identified three varieties - IBV 8001, IBV 8004 and H7-66 superior or equally good yielders as the best released vûrioty Souna 3 and coupled with botter resistance to diseases. More testing is needed before the varieties could be recommended for release.

REFERENCES

BILQUEZ, A.F. 1974.-
Amélioration dos mils au Sénégal - Synthèse des résultats obtenus au cours dos quatre promières années de travail et conclusions générales.
CNRA, ISRA, BAMBEY : 1-57.

BONO, M. and P. LECLERCQ 1963.-
Méthodes d'amélioration variétale dos mils et sorghos utilisées au CRA de Bambey. L'Agronomie Tropicale 18 (1) : 33-52.

BOURIQUET, G. 1963.-
Les principaux ennemis et maladies du sorgho et du mil en Afrique tropicale. L'Agronomie Tropicale 18 (1) : 132-136.

DANCETTE, C. 1974.-
Comment adapter les cultures à l'aridité du milieu et améliorer co milieu. Conférence-atelier sur le Sahel. CNRA, Bambey : 1-21.

ETASSE, C. 1965.-
Amélioration du mil Pennisetum au Sénégal. L'Agronomie Tropicale 20 (10) : 976-980.

ETASSE, C. 1969.-
Amélioration du mil Pennisetum au CRA de Bambey état actuel des travaux et orientations - Communication à la Conférence céréale de Zaria/Nigéria du 13 au 16 octobre : 1-9.