Current Status of Sorghum Smuts in Nigeria

PaulS. Marley
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ABSTRACT. Survey of farmers' fields in major sorghum growing areas within the four climatic zones of the Nigerian savanna established changing patterns in the incidence, severity and distribution of sorghum smuts. Covered smut *(Sponsorium sorghi)* although widely distributed, was found to be highly predominant in the Sudan (24.8%) and northern Guinea (29.5%) savanna. Loose smuts *(Sphacehiheco cruenta)* and long smuts *(Tolxposporium ehrenbergii)* were most prevalent in the Sahel savanna (21.8% and 15.5%, respectively). Head smut *(Sporisorhtm reliamtm)* was absent in the Sahel and Sudan, low in northern Guinea savanna zones, but was most predominant in the southern Guinea savanna. These smuts are economically important and continue to be a major biotic constraint in the effort to sustain high sorghum production levels. *[Article copies available for a fee from The Hawonh Document Delivery- Service: 1-800-342-9678. E-mail address: getinfo(Q.haworihpressinc.com <Webshe: http:liwww.hawortbpressiiic.com>]*

KEYWORDS. Nigeria, sorghum, sorghum smuts

INTRODUCTION

Sorghum, *Sorghum bicolor* [L.] Moench is one of the most important cereal crops grown in the savanna zones of Nigeria. It occupies about 40% of

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the total land area devoted to cereal production and has an estimated current production of about 8 million metric tonnes (NAERLS, 1996).

Smuts of sorghum continue to be the most important and widespread panicle diseases in the Nigerian savanna, where they cause damage both on traditional and improved cultivars. All four smuts are found on rainy season sorghums in Nigeria, these are covered smut (*Sporisorium sorghi* [Ehrenberg] Link), loose smut (*Spacelotheca cruenta* [Kuhn] Potter), head smut (*Sporisorium reilianum* [Kuhn] Langdon and Fullerton) and long smut (*Tolyposporium ehrenbergii* [Kuhn] Patouillard) (Harris, 1962). However, only covered smut is found on post-rainy season sorghum locally called "Masakwa" grown under residual moisture conditions in the Chad basin (Olabanji et al., 1996).

The major symptom of these smuts is the development of smut sori or black spore-filled pustules or sacks in place of individual florets or of the entire sorghum head. Covered smut is characterised by smooth, spherical to cylindrical sori which develop in place of the ovary or stamens of individual florets. Florets may support a single sorus in place of the ovary or fused sori in place of both ovary and stamens. In loose smut, the sori peridia ruptures soon after the emergence of the heads and long columella (deformed remains of florets) protrudes from the glumes after the spores have been dispersed. Sori commonly develop on the rachis and its branches, sometimes on glumes and occasionally on peduncles and stalks. Head smut is characterised by the entire or part of the panicle developing into a single, large sorus. The sorus has a thick, whitish peridium that ruptures readily after exsertion and the black mass of teliospores gradually falls to the soil. Dark filaments which are remnants of the vascular tissues remain until the teliospores have been shed. Long smut can be identified by the large, long, cylindrical, slightly curved sori that are formed on individual florets on a panicle. Sori are enclosed in a relatively thick, grey to brown peridium composed of fungus tissue (Zummo, 1984).

Earlier estimates show smuts to account for between 5-10% yield loss and therefore economically important (Manzo, 1975; Selvaraj, 1980). The use of seed dressing chemicals, the identification and use of smut resistant varieties, the use of field sanitation and other cultural control methods and changing husbandry and farming practises by farmers appeared to reduce the incidence and severity of the smuts. However, observations in recent years have shown an apparent increase in their incidence, severity and changes in their distribution and these, therefore brought about the need to establish the current status of these diseases.

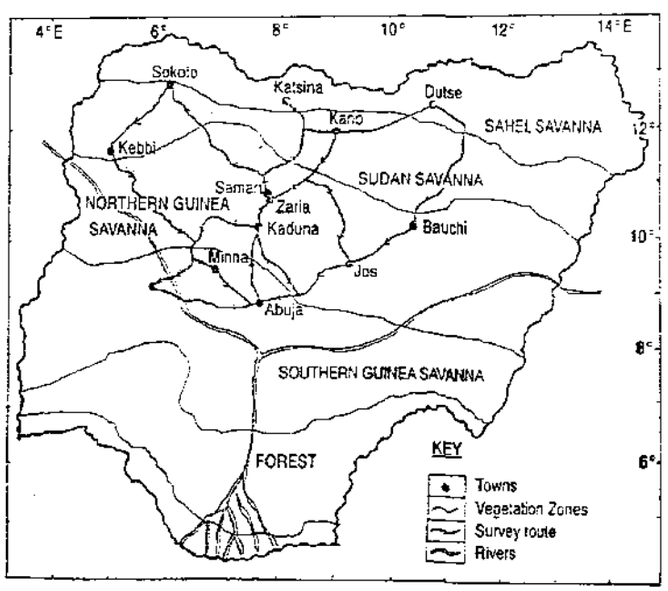
This paper presents results of surveys in farmers' fields carried out from 1993 to 1996 to determine the incidence, severity and distribution pattern of sorghum smuts in Nigeria.

MATERIALS AND METHODS

Surveys

Surveys were carried out in farmers' fields in major sorghum growing areas of the Nigerian savanna from 1993 to 1996. These surveys were conducted from October to December when the sorghum crop was at physiological maturity depending on the climatic zone. From 1993 to 1995, surveys were carried out in farmers, fields within a 100 km radius of Samaru, while in 1996, a systematic survey was conducted throughout the major sorghum growing areas within the Sahel, Sudan, northern Guinea (NGS) and southern Guinea (SGS) savanna zones which constitute the main sorghum growing areas in Nigeria (Figure 1). In surveys within the Samaru 100 km radius, 55 farmers fields were visited per year. In the systematic survey, stops were made at intervals of 15-100 km distance on a survey route of about 4500 km. Stops were less frequent in areas where sorghum was sparsely cultivated. At

FIGURE 1. Survey route in the major sorghum growing areas of the Nigerian savanna, 1996 cropping season.



each stop, between one to 10 fields were examined and a total of 459 were examined, 71 in the Sahel, 106 in Sudan, 184 in NGS and 98 in SGS.

In each field, the method of sampling was modified from Pande et al. (1993), where the field was divided into four quadrants and in each quadrant, 50 plants on 10 randomly chosen rows were assessed for incidence and severity of the different smuts. The incidence in each field at a location was used to calculate the location average and the incidence at each location was used to calculate the incidence of each smut per zone.

Disease Assessment

The incidence of smuts was scored on a visual rating scale of 1-9 where 1 = no infected panicles, 2 = < 5% of panicles infected, 3 = 6-10% of panicles infected, 4 = 11-20% of panicles infected, 5 = 21-30% of panicles infected, 6 = 31-40% of panicles infected, 7 = 41-50% of panicles infected, 8 = 51-75% of panicles infected and 9 = > 75% of panicles infected.

Disease severity was scored for each panicle examined and found to have covered and long smut incidence. Each panicle was assessed based on a 1-9 scale modified from Thakur and King (1988) where 1 = clean panicle with no infection, 2 = < 1% seeds infected/head, 3 = 1-5% seeds infected/head, 4 = 6-10% seeds infected/head, 5 = 11-20% seeds infected/head, 6 = 21-35% seeds infected/head, 7 = 36-50% seeds infected/head, 8 = 51-75% seeds infected/head and 9 = > 75% seeds infected/head.

RESULTS

The incidence of the four smuts in 55 farmers' fields surveyed around Samaru area during 1993-1995 cropping seasons is shown on Table 1. The incidence of covered smut increased from 41% infected panicles in 1993 to more than 75% infected panicles in 1995 with a corresponding increase from 10.9% to 20.0% of fields observed with the disease within the same period. Long and Head smuts incidence were low and remained at less than 5% infected panicles within the fields. Loose smut incidence also remained at less than 5% infected panicles, but the number of fields with the disease increased to 5.5%.

Results of the systematic survey of 1996 show that for covered smut, NGS had 29.4% out of 184 fields showing disease with between 30 to 40% of the panicles infected. In the Sudan savanna, 24.5% out of 106 fields showed disease with incidence of 5.7 (> 21 to < 30% of panicles infected). Sahel and SGS zones had 12.7% and 11.2% of 71 and 98 fields infected with disease and incidence rated at 3.3 and 4.3, respectively (Table 2). Long smut was

TABLE 1. Incidence of four smuts in 55 farmers' fields surveyed in the Samaru area from 1993 to 1995 (Northern Guinea Savanna) of Nigeria.

Smut	Fields with disease	% fields with disease	Disease incidence[1]
1993			
Covered	6	10.9	7
Long	1	1.8	2
Head	2	3.6	2
Loose	1	1.8	2
1994			
Covered	8	14.6	8
Long	1	1.8	2
Head	1	1.8	2
Loose	1	1.8	2
1995			
Covered	11	20.0	8
Long	1	1.8	2
Head	1	1.8	2
Loose	3	5.5	2

[1]Incidence scored on a 1-9 visual scale where 1 = no infected panicle, 2 = < 5% of panicles infected, 3 = 6-10% of panicles infected, 4 = 20% of panicles infected, 5 = 21-30% of panicles infected, 6 = 31-40% panicles infected, 7 = 41-50% of panicles infected, 8 = 51-75% of panicles infected and 9 = >75% of panicles infected.

observed in 15.5% of fields surveyed in the Sahel, 4.0% in the Sudan, and 2.9% in NGS, but was not observed in the SGS during this survey. Disease incidence was 5.0, 3.3, 2.0 and 1.0, respectively. Head smut was not observed in the Sahel and Sudan while in the NGS, it was low during this survey. However in the SGS, up to 4.5% of the fields showed disease with an incidence of 2.7 (< 5% panicle infected). Loose smut in the Sahel was observed in 21.8% of fields followed by Sudan with 16.3%, NGS with 3.9% and the SGS with 0.1%. Disease incidence was 3.7, 3.3, 2.0 and 2.0, respectively.

The severity of covered smut for each of the zones is shown in Figure 2. Severity ranged from 3-9 in the Sahel and Sudan, 4-9 in the NGS while in SGS, it ranged from 2-8. Similarly, long smut severity in the zones (Figure 3) ranged from 2-7 in the Sahel, 3-6 in the Sudan and 2-5 in the NGS. Average severity for covered smut was highest in the NGS with 7.7 followed closely by Sudan with 7.3. Disease severity for Sahel and SGS were 6.9 and 5.2, respectively. Long smut severity was also highest in the Sahel with 6.4 followed by Sudan with 6.0 while NGS had 3.1 (Figure 4).

TABLE 2. Incidence of four sorghum smuts in 459 fields surveyed in four savanna zones of Nigeria, 1996 cropping season.

Zone	No. of fields surveyed	Fields with disease	% fields with disease	Disease incidence[1]
Covered smut				
Sahel	71	9	12.7	3
Sudan	106	26	24.5	5
NGS	184	546	29.4	6
SGS	98	11	11.2	4
Long smut				
Sahel	71	11	15.5	5
Sudan	106	4	4.0	3
NGS	184	5	2.7	2
SGS	98	0	0	1
Head smut				
Sahel	71	0	0	0
Sudan	106	0	0	0
NGS	184	7	3.8	2
SGS	98	18	18.4	2
Loose smut				
Sahel	71	15	21.8	4
Sudan	106	17	16.3	3
NGS	184	4	3.9	2
SGS	98	1	1.0	2

[1]Incidence scored on a 1-9 visual scale where 1 = no infected panicle, 2 = < 5% of panicles infected, 3 = 6-10% of panicles infected, 4 = 20% of panicles infected, 5 = 21-30% of panicles infected, 6 = 31-40% panicles infected, 7 = 41-50% of panicles infected, 8 = 51-75% of panicles infected and 9 = >75% of panicles infected.

DISCUSSION

Research work on sorghum smuts in Nigeria has been in progress since 1957 (Harris, 1963). Initially, studies were restricted to routine diagnosis of diseases, recording outbreaks and advising farmers on field sanitation and other forms of control (Harris, 1962). However, not until 1980 when reports showing the distribution of the various smuts began to appear in literature. Tyagi (1980) stated that covered, loose and head smuts were found in all sorghum growing areas of Nigeria. He further stated that long smut appeared to be restricted to the drier parts of northern Nigeria specifically in the Sahel and Sudan as earlier reported by Manzo (1975; 1976), although Adeoti (1993) reported the incidence of long smut in a farmer's field in the relatively wetter southern Guinea savanna.

FIGURE 2. Severity of covered smut in diseased fields (%) in four climatic zones of Nigeria, 1996 cropping season. Disease severity based on a 1-9 rating scale, where 1 = clean panicle with no infection, 2 = <1% seeds infected/head, 3 = 1-5% seeds infected/head, 4 = 6-10% seeds infected/head, 5 = 11-20% seeds infected/head, 6 = 21-35% seeds infected/head, 7 = 36-50% seeds infected/head, 8 = 51-75% seeds infected/head and 9 = >75% seeds infected/head.

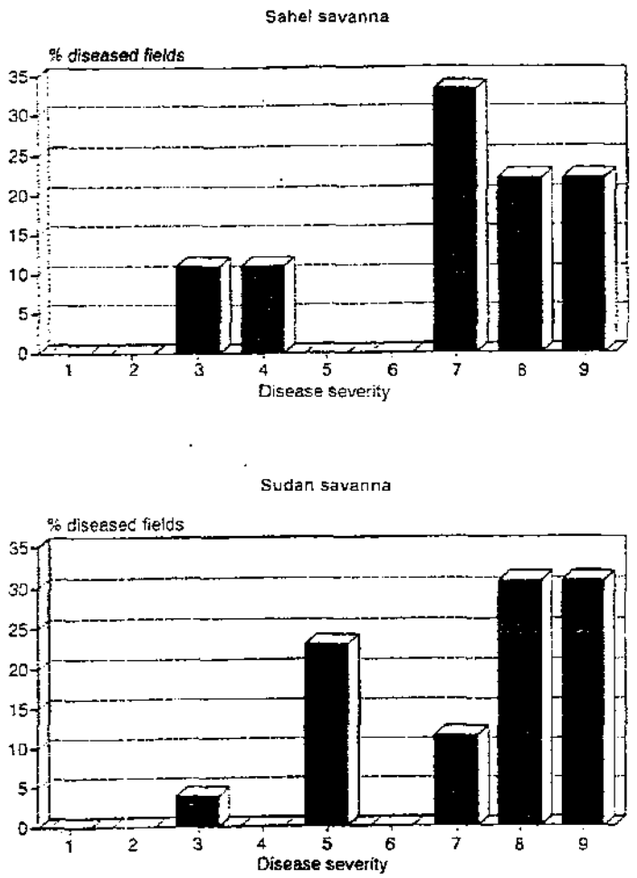
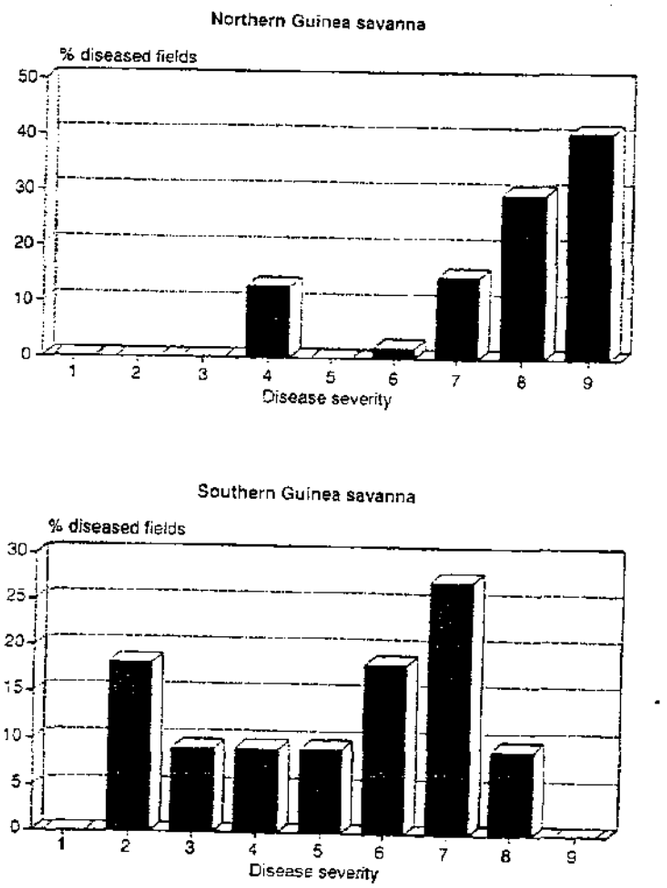


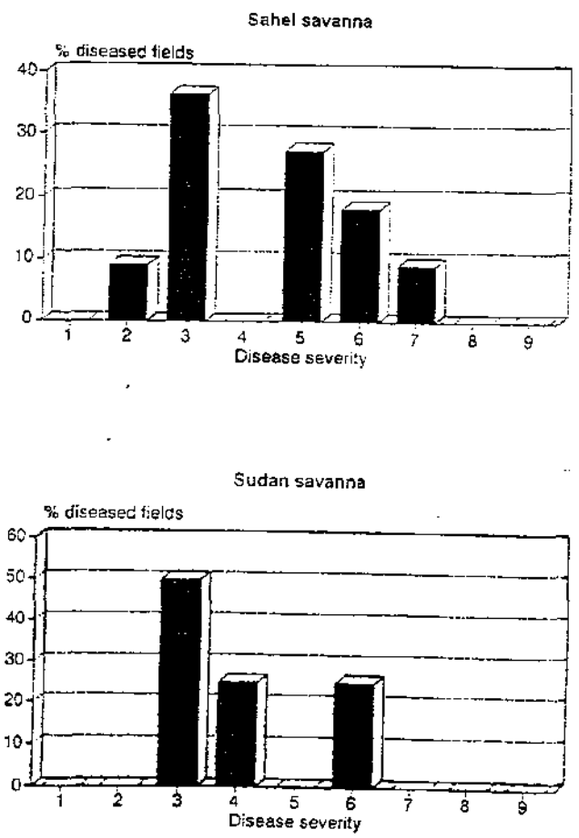
FIGURE 2 (continued)



The first elaborate attempt at showing the distribution of smuts in Nigeria was reported by Selvaraj (1980) based on surveys conducted from 1975 to 1978 while Pande et al. (1993) further reviewed the status of these diseases on sorghum in Nigeria.

The distribution of the four smuts as observed during the surveys reported

FIGURE 3. Severity of long smut in disease fields (%) in three climatic zones of occurrence in 1996 cropping season. Disease severity based on a 1-9 rating scale, where 1 = clean panicle with no infection, 2 = <1% seeds infected/head, 3 = 1-5% seeds infected/head, 4 = 6-10% seeds infected/head, 5 = 11-20% seeds infected/head, 6 = 21-35% seeds infected/head, 7 = 36-50% seeds infected/head, 8 = 51-75% seeds infected/head and 9 = >75% seeds infected/head.



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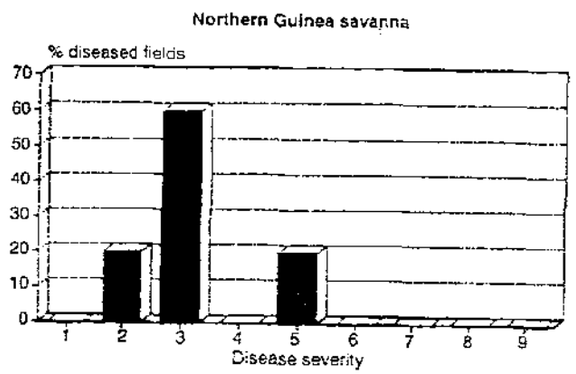
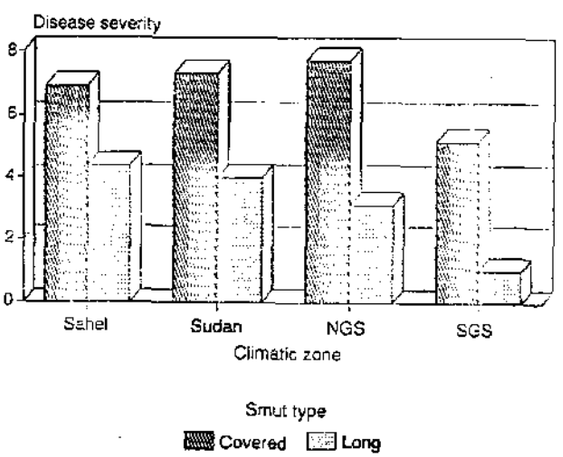


FIGURE 4. Average severity for covered and long smut in infected fields in four climatic zones of Nigeria in the 1996 cropping season. Disease severity based on a 1-9 rating scale, where 1 = clean panicle with no infection, 2 = <1% seeds infected/head, 3 = 1-5% seeds infected/head, 4 = 6-10% seeds infected/head, 5 = 11-20% seeds infected/head, 6 = 21-35% seeds infected/head, 7 = 36-50% seeds infected/head, 8 = 51-75% seeds infected/head and 9 = >75% seeds infected/head.



herein indicate changing patterns. Although covered smut was present in the Sahel, Sudan, NGS and SGS savanna zones (Selvaraj, 1980), the incidence has increased dramatically as observed in this survey. A recent report by Pande et al. (1997) supports this findings. The disease appears to have also increased in the SGS as results obtained in this survey indicated higher incidence than other reports (e.g., Adeoti, 1993; Pande et al., 1993). Reports by Tyagi (1980) and Selvaraj (1980) had indicated that traditional cultivars were more susceptible than improved cultivars. From observations during this survey, improved cultivars such as BES and its relatives, SK 5912 and ICSV 400 which are widely cultivated were highly susceptible to the disease. Loose smut was observed to have also increased in incidence around the Sudano-Sahelian zones. This disease although widespread, was reported earlier to be light and sporadic, occasional in occurrence (Selvaraj, 1980). Observations from this survey show that it has become abundant and occurred on traditional and improved cultivars within these zones. Changes in covered and loose smuts status could be attributed to many factors such as increased cost and erratic supply of agricultural inputs (Okewu, 1984; Poswal and Akpa, 1991). These diseases are reported to be easily controlled by seed treatment chemicals (Sundaram, 1980; Selvaraj, 1980), however, present costs of agricultural inputs impede their use by resource-poor farmers who form the bulk of sorghum producers in Nigeria. Lack of suitable seed treatment chemicals to control these diseases may contribute to increased incidence. Reports by Marley (1995a, 1996, 1977) have shown that thiram-based seed treatment formulations continue to be the best for control of covered smut, but these are presently almost absent from the Nigerian market. The existence of an alternative host for the covered smut pathogen (Marley, 1995b) could also provide increased source of inoculum.

Long smut continues to be a disease of the dry areas as the disease was observed to be more in the Sahel savanna than any of the other zones. Pande et al. (1993) also found a similar high incidence of the disease in the Sahel, although Selvaraj (1980) had earlier observed the disease to be very important in the Sahel and Sudan savanna zones. During the survey, the disease was observed on improved and local cultivars. The occurrence of head smut was absent in the Sahel and Sudan, low in NGS, but was found to be very common in the SGS. However reports by Selvaraj (1980) had earlier indicated that the disease had increased considerably in the Sudan and NGS zones and was associated with dry conditions (Frowd, 1980), while Pande et al. (1993) reported the disease to be most predominant in the Sudan. The predominance of the disease in the SGS as observed possibly indicates that the disease is more associated with wet conditions as observed by (Frowd, 1980). This predominance could also be consistent with observations that much of it occurred on late-maturing cultivars, which are predominantly

cultivated in this zone, while mostly short and medium maturing cultivars have been adopted by farmers in the Sudano-Sahelian zones. In fields that the disease occurred, it was found to be more prevalent near trees with abundant shade. This observation is similar to the "tree effect" reported by King (1970).

The economic importance of smuts in West Africa and particularly in Nigeria have been determined. Keay et al. (1967) reported average losses of between 5-10% of total yield while Harris (1963) had estimated a 1.3% loss due to covered smut alone at £500,000.00 or the unrewarded cultivation of 70,000 acres. The management of these smuts is therefore important for continued sustainable production of sorghum in Nigeria. Efforts at controlling covered and loose smut using seed dressing chemicals reduced their incidence in the early 1970s (William et al., 1976). However, for reasons mentioned earlier and inappropriate provision of extension services capable of disseminating relevant information to farmers, which are prerequisites for sustainable agricultural development (Abdulai and Hazell, 1995) have made these diseases to remain a serious constraint to sorghum production as most farmers are resource-poor. To achieve higher and sustainable levels for sorghum production, integrated control approaches to these diseases involving cultural practises, chemical control and use of resistant varieties by farmers must be emphasized. Many of these measures have been identified (e.g., Selvaraj, 1980; Marley and Aba, 1997).

CONCLUSION

It is clear from these findings that the current status of sorghum smuts is different from that observed by earlier workers. In general, the incidence, severity and distribution of covered and loose smuts have increased. Covered smut is highly prevalent in all the climatic zones, while loose smut appears to be confined to the Sahel, Sudan and NGS. Long smut continues to be associated with dry conditions prevalent in the Sudano-Sahelian zones of the country while head smut is more predominant in the relatively wetter SGS. There is an apparent need for an integrated control approach for these smuts.

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The Agricultural Marketscape: A Framework for Sustaining Agriculture and Communities in the Northeast

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Judy Green

ABSTRACT. This paper examines ways in which rural landscapes and communities in the Northeast have been, and continue to be, impacted by global and local food marketing systems. We provide a historical overview of globalization in agriculture and the food system and the relationship of these changes to other economic, technological and social changes. We present two food system models–"global" and "local"–representing contrasting socioeconomic paradigms, or understandings of the true and proper relationship between economy and society. Finally we explore some of the theoretical and real-life impacts of global and local food systems on landscapes in the Northeast, and discuss implications for achieving long-term agricultural sustainability. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-342-9678. E-mail address: getinfo@haworthpressinc.com <Website: http://www.haworthpressinc.com>]*

KEYWORDS. Community agriculture development, sustainable agriculture, rural communities, marketscapes

INTRODUCTION

There is a growing awareness among scholars, policy makers, and ordinary citizens that the economic viability of farming must be improved if we

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