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Crop losses due to insects in the savannah area of Ivory Coast: a review

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Abstract. The crop losses due to insects in the savannah area of the Ivory Coast during the past few years are presented for the main crops (cotton, maize, irrigated rice, groundnut) and for some stored products (maize, yam). Losses of 60% are found in the southeast of the area for cotton and maize. For these two crops, as well as for stored products, the entomological risk decreases northwards and westwards. For the other crops, losses are similar throughout the whole area, reaching 30% for the irrigated rice whereas groundnut is little attacked (2·4% losses). The main insect pests are mentioned.

Introduction

The importance of the study of crop losses has been outlined by various authors (Cramer, 1967; Chiarappa *et al.*, 1971; Bardner and Fletcher, 1974; Mackenzie, 1979; Walker, 1983).

Most of the papers deal with losses of one crop in one place. In the developing countries, there are few studies of several crops and several localities. Cramer (1967) noted the lack of information in some countries, which sometimes forced him to estimate losses from the data of neighbouring countries in his attempt to assess losses in the world.

In recent years, there have been various works on crop losses in the savannah area of Ivory Coast. The aim of this paper is to review the results obtained for the main crops (cotton, maize, irrigated rice, groundnut) as also for some stored products (maize, yam).

Methods

The savannah area of Ivory Coast stretches from latitude 6°5 N to 10°3 N and from longitude 3° W to 8° W (Figure 1). This zone, which may be divided into a sudan zone, north of 8° N, and a guinea zone, south of 8° N, is the district of

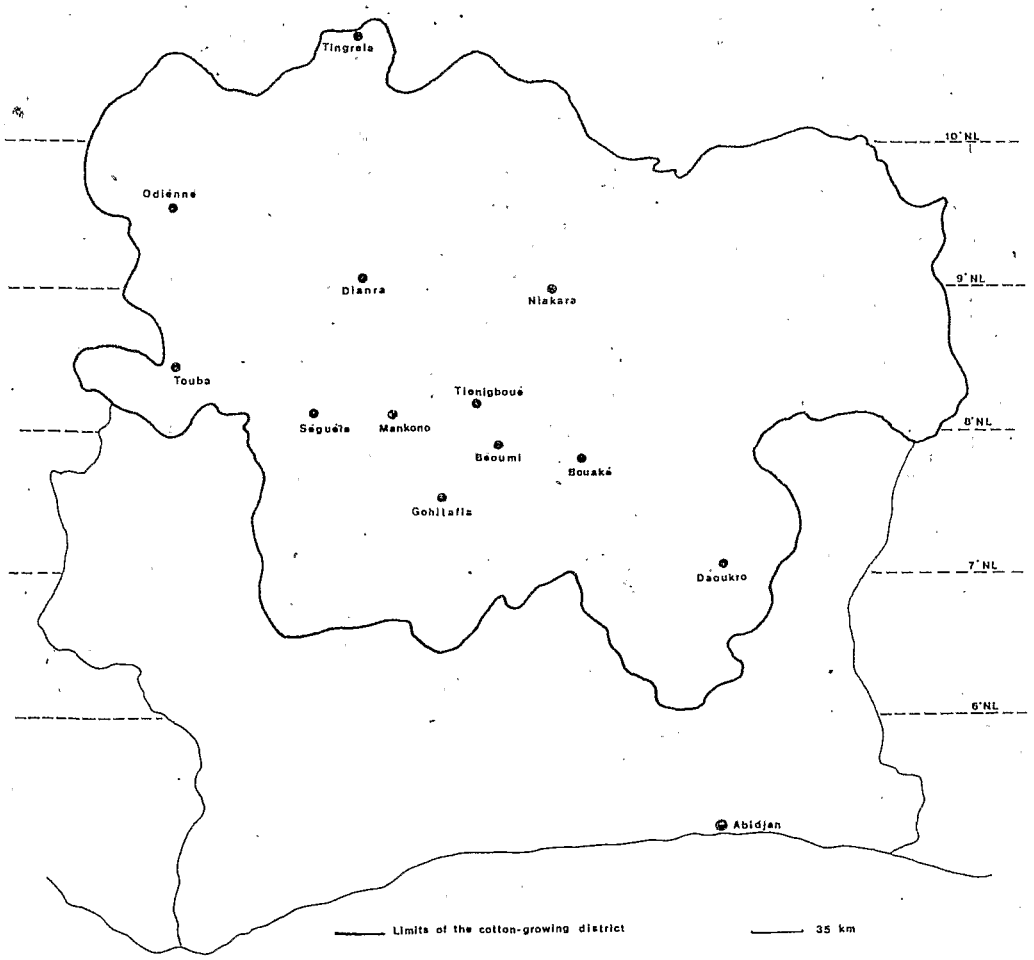

Figure 1. Map of Ivory Coast showing the limit of the cotton-growing district which suits the savannah area.

cotton-growing and covers about 60% of Ivory Coast. The estimated areas of the main crops grown in this area in 1983 are presented in Table 1 (Ministère de l'Agriculture, 1983).

Table 1. Area of the main crops grown in the savannah area of Ivory Coast in 1983

Crop	Area (ha)
Cotton	128384
Maize	302700
Rice	139900
Yam	166440
Groundnut	82500

Crop losses have been estimated by comparison between fields without protection, with a little protection and strongly protected by insecticides.

The percentage of loss is obtained by substracting the yield of the unprotected from the protected field and dividing the result by the yield of the protected field and multiplying by 100.

This method of assessment is not free from bias (Le Clerg, 1971; Walker, 1983). First, only insects must be destroyed. Among the results below, there is only one example where this condition is not so: *Polyphagotarsonemus latus*, a mite pest of cotton, is destroyed by the pesticides used. Some of the yield losses of cotton mentioned below may be due to this mite, which may be locally important, especially in the south of the district.

Such a problem could also occur in irrigated rice, where some of the insecticides are nematicidal. Thus, carbofuran, although used at the low rate of 390 a.i./ha, has some nematostatic effect (Cadet *et al.*, 1980). However, these pesticides did not give better yields than the pure insecticides (Sauphanor and Moyal, 1987), and it can be assumed that nematodes were not an important cause of yield losses in the trials reviewed.

Secondly, the pesticide must not have a phytostimulating or phytotoxic effect on crop production. A stimulating effect has been observed by Cadet *et al.* (1980) with carbofuran on irrigated rice, but only at rates greater than those used here. This is the only instance in the trials reviewed below.

Most of the results have been obtained on 'observation sites', where the way of working and yields are intermediary between those of the farmer and those of experimental stations. Varieties frequently grown by farmers have been used.

Results

Cotton

Cotton is attacked by many insect pests in the Ivory Coast. During the vegetative stage, most pests are piercing–sucking: *Empoasca fascialis* (Jassidae), *Lygus vosseleri* (Miridae), *Helopeltis schoudeteni* (Miridae), and Lepidoptera: *Sylepta derogata* (Pyralidae), *Cosmophila flava* (Noctuidae), *Spodoptera littoralis* (Noctuidae). The mite *Polyphagotarsonemus latus* is also a pest of the vegetative stages, mostly in the southern part of the area.

Flower buds and bolls are attacked by lepidopterous larvae of *Diparopsis watersi* (Noctuidae), *Earias insulana* and *E. biplaga* (Noctuidae), *Heliothis armigera* (Noctuidae), *Cryptophlebia leucotreta* (Olethreutidae), *Pectinophora gossypiella* (Gelechiidae). Since 1982, outbreaks of *Bemisia sp.* (Homoptera, Aleyrodidae) have occurred in the northern part of the area during this stage, heeding the use of insecticide.

Others insects may become more important such as *Podagrica sp.* (Coleoptera, Chrysomelidae) attacking the glandless varieties that are now being grown in the Ivory Coast (Couilloud, 1983; Moyal, 1983; Vaissayre *et al.*, 1984; Vaissayre, 1985; Vaissayre and Hau, 1985).

These pests cause important yield losses. Vaissayre *et al.* (1984) surveyed the losses observed from 1978 to 1983, comparing intensively protected plots and weakly protected plots (2 insecticide treatments at 45 and 59 d.a.e., in order to initiate flowering) (Table 2). These losses are greater than 60% south of the 9th parallel and about 35% north of the 9th parallel, approximately the northern boundary of attack by *Heliothis armigera*.

Table 2. Crop losses due to insects in the savannah area of Ivory Coast

Crop	Part of the zone and time of cultivation	Yield of the highly protected field (kg/ha)	Yield of the poorly or unprotected field (kg/ha)	Percentage of yield loss
Cotton	North of 9th parallel	2634	1708	35·2
	South of 9th parallel	2198	807	63·3
Maize	First cycle in the south part (Bouaké, Béoumi, Gohitafla, Daoukro)	2980	2522	15·4
	Main cycle			
	North of 9th parallel	3550	3335	6·0
	West (Dianra, Touba, Séguéla)	3863	3725	3·6
	South centre (Niakara, Bouaké, Béoumi)	3227	2214	31·4
	South-south-east (Gohitafla, Daoukro)	2205	950	56·9
Irrigated rice	Whole of the savannah area			
	First cycle	4737	3373	28·8
	Second cycle	4570	3667	19·8
Groundnut	Whole of the savannah area	1750	1708	2·4

Maize

Dabiré (1980), Moyal (1983, 1984, 1985, 1988) and Odjo (1984) studied the pests of maize in the savannah area of Ivory Coast. The main problems are due to maize borers, five species of which are met in the district: *Eldana saccharina* (Lepidoptera, Pyralidae), *Busseola fusca* (Lepidoptera, Noctuidae), *Sesamia calamistis* (Lepidoptera, Noctuidae), *Mussidia nigrivenella* (Lepidoptera, Pyralidae) and *Cryptophlebia leucotreta* (Lepidoptera, Olethreutidae). The last two are only cob borers whereas the first three attack stem and cob.

Percentage of yield loss of a non-protected plot in comparison with a field protected by insecticide treatments applied every 10 days is presented in Table 2 (Moyal, 1988). The first cycle of maize, sown in February–March, has been distinguished of the main cycle, sown in June. The latter can be grown in each region of the savannah district whereas the first cycle is possible only in the south where two rainy seasons occur.

Yield loss appears to be very low in the north and important in the south and southeast, where loss can reach about 60% for the crop sown in June.

Maize streak virus is another problem of insect origin, investigated by Moyal (1984, 1985). Table 3 summarizes the results obtained. In 1983, a dry year, levels of attack reached about 100% in Béoumi, in the south, and in 1984, 30% of plants were attacked in Daoukro, in the southeast. Lamy *et al.* (1980) found 20% of plants attacked in 1977 around Bouaké. The yield loss estimated in Niakara in 1984 (Moyal, 1985) reached 9% when the percentage of plants attacked was 13·5%. These figures show the importance of this problem, which has been little studied.

The protection of maize seeds did not reveal any insect injury at this stage (Moyal, 1985).

Table 3. Percentage of maize plants attacked by maize streak virus at 60 days after emergence in the savannah area of Ivory Coast (maize sown in June)

	Year	
Localities	1983	1984
North (Tingrela)	5	3·6
North-centre (Niakara)	5	13·5
West (Touba, Dianra)	0	0
Southwest (Séguéla, Tiénigboué)	12·5	2·4
South-centre (Béoumi, Bouaké, Gohitafla)	37	14·5
Southeast (Daoukro)	—	30·8

Irrigated rice

Several authors have studied the insect pests of irrigated rice in Ivory Coast: Tavakilian (1977), Tran (1977, 1981), Cochereau (1978), Lor (1978), Na (1978), Moyal (1982), Sauphanor and Moyal (1987). As for maize, the main insect pests are stem-borers, in the Diptera and Lepidoptera: *Orseolia oryzivora* (Cecidomyiidae), *Pachylophus beckeri* (Chloropidae), *Hydrellia prosternalis* (Ephydridae), *Diopsis apicalis* and *D. thoracica* (Diopsididae) for the Diptera; *Maliarpha separatella* (Pyralidae), *Scirpophaga melanoclista* (Pyralidae), *Chilo zacconius* and *C. diffusilineus* (Pyralidae), *Eldana saccharina* (Pyralidae), *Sesamia calamistis* (Noctuidae) for the Lepidoptera.

Sometimes, outbreaks of phyllophagous insects occur: the main are those of *Nymphula depunctalis* (Lepidoptera, Pyralidae), *Trichispa sericea* (Coleoptera, Chrysomelidae) and *Spodoptera exempta* (Lepidoptera, Noctuidae).

Yield loss due to insects has been assessed by Moyal (1983, 1984, 1985) and Sauphanor and Moyal (1987). The results in Table 2 give the percentage of yield loss of an unprotected field when compared with a field protected during the first third of the cultivation period, as practiced by farmers. The yield loss is thus underestimated in comparison with a field protected all through cultivation. However late attacks are mainly due to *Maliarpha separatella* and generally have little effect on yield (Sauphanor and Moyal, 1987).

As no important difference was noticed between the trial localities, the mean losses for the whole area are presented in Table 2. We only made a distinction between the first and second cycle plantings. The results, obtained in farmers' fields, indicate a yield loss of about 30% for the first and 20% for the second cycle.

Groundnut

Yield losses of groundnut occur at the seedling and the maturation stages, but are of little importance (Moyal, 1984) (Table 2). The seedling pests found were Coleoptera Elateridae, whereas the losses at harvest were due to termites and diplopods. Attacks of Thysanoptera were sometimes seen during the vegetative phase but no yield increase resulted from insecticide protection.

Stored products

Various studies have been devoted to insect pests of stored cereals and yams (C.I.D.T., 1982; Ratnadass and Sauphanor, 1983; Sauphanor *et al.*, 1983; Moyal, 1984; Ratnadass, 1984; Sauphanor and Ratnadass, 1985). The main pests of stored maize are *Sitophilus zeamais* and *S. oryzae* (Coleoptera, Curculionidae); on stored rice, mainly *Sitotroga cerealella* (Lepidoptera, Gelechiidae). Among other insects the most frequent are *Cathartus quadricollis* (Coleoptera, Sylvanidae) and *Carpophilus dimidiatus* (Coleoptera, Nitidulidae). Ratnadass (1984) numbered 18 species on maize and 10 on paddy.

Stored yams are mainly injuried by two lepidopterous larvae: *Euzopherodes vapidiella* (Pyralidae) and a species not yet described belonging to the Tineidae (Sauphanor and Ratnadass, 1985). Moyal (1984) studied the attacks of stored yams by lepidopterous larvae and by the coccid *Aspidiella hartii* in all the savannah area for two species of yam: *Dioscorea alata* and *Dioscorea cayenensis*. Percentages of attacked tubers reach 50% in some localities after 5 months of storage (Table 4). Weight losses are mainly due to lepidopterous larvae, while the coccids reduce germination (Sauphanor and Ratnadass, 1985; Moyal, 1984).

Table 4. Percentage of yam tubers attacked during storage in 1983 in the savannah area of Ivory Coast after an average storing time of 5 months

Localities	Yam species	Percentage of attacked tubers by: Coccids	Lepidopterous larvae
West-north-west (5 localities)	*D. alata*	53	14
West-north-west (4 localities)	*D. cayenensis*	51	8
South-centre (6 localities)	*D. alata*	32	55
North-centre (1 locality)	*D. alata*	10	14
Southeast (1 locality)	*D. alata*	45	18

Other injuries occur before harvest, mainly due to *Heteroligus meles* (Coleoptera, Dynastidae). Rémillet (1973) found 12% of attacked tubers in Mankono in 1965. However, during recent years, attacks have been light.

Losses observed on stored maize and yams are presented in Table 5.

Table 5. Percentage of weight loss due to insects during storage of maize and yam in the savannah area of Ivory Coast

Crop	Locality	Percentage of loss	Duration of storage (months)
Maize	North of savannah area	0·6	7
	South-centre of savannah area	5·9	7
Yam	South-centre	10%†	5
		1%‡	5

†on *Dioscorea alata* (variety Florido)
‡on *Dioscorea cayenensis* (Variety Krengle)

Discussion

The results reviewed above indicate that yield losses due to insects are often very important, reaching about 60% for cotton and maize in the southern part of the savannah area, and 30% for irrigated rice during the first cycle of cultivation.

One of the main features of insect injury is the increase of attack southwards and eastwards, whereas attacks become weaker westwards and northwards. This is the pattern for cotton, maize and stored cereals. After several years of survey, we can distinguish a high entomological risk in the south of savannah district and very weak risk in the north and west.

It must be noted however that these quantitative losses may not fully explain the entomological risk. Thus, *Bemisia sp.*, attacking cotton shortly before harvest, has no influence on the yield but is important because of the loss of value of the cotton fiber following honeydew contamination. Likewise, even little injuries on stored yams can provide products hardly marketable.

Nevertheless, knowledge of the crop losses found during the last few years and presented here provides a more precise idea of the entomological risk in the savannah area of Ivory Coast. It is now possible to choose the crops, the periods of cultivation and the chemical methods of crop protection with respect to the risk of yield losses. Thanks to these results and to knowledge about the ecology and parasitism of insect pests and the tolerance of crop varieties, it is now possible to implement integrated pest management methods.

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