Yam pests in the Ashanti and Brong Ahafo regions of Ghana: A study of farmers' indigenous technical knowledge and control practices

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ABSTRACT

In Ghana, yam is a very important indigenous subsistence and cash crop that is now the most popular non-traditional export food crop, despite years of scientific neglect. There is a general paucity of technical information on yam production and marketing constraints, but especially so for pests and their management. To understand and document farmers' needs as a basis for developing technologies to meet their requirements, this study surveyed yam farmers' indigenous technical knowledge about pests on their crops and their pest management practices over the years in two districts in Brong Ahafo Region and one in Ashanti Region. Pre-tested questionnaire were administered to 30 randomly selected farmers in five villages in each district. The results showed that farmers' knowledge about pests and the pest spectra were similar for the three districts. Farmers knew about insect pests on their yams, but were neither able to draw interrelationships between pest populations and damage nor the cultural practices that they follow or the ecological state of their farms. Termites (*Amitermes* spp., *Macrotemes* spp., and *Microtermes* spp.) were considered more important pests than millipedes (*Peridontoyge* spp.), tuber beetles (*Heterolygus meles* and *Prionorcytes rufopiceus*), mealybugs (*Pseudococcus brevipes, Planococcus dioscorea* and *Ferrisia virgata*), and scale insects (*Aspidiotus destructor* and *Aspidiella hartii*) in that order. Out of 12 white yam varieties cultivated in the area, "Pona" was identified to be most susceptible to pest attack and "Dentepruka" least susceptible. Anthropological factors such as farmer's origin or residency status, level of education, age, marital status, family size, and the land tenure system were also found to play key roles in the technologies adopted in cultivating yams. The implications of the findings, particularly in identifying appropriate experimental variables for technology generation and transfer to improve yam resource productivity, are discussed.

RÉSUMÉ

BRAIMAH, H., ANCHIRINAH, V. M. & ADU-MENSAH, J.: *Les ravageurs d'igname dans les regions d'Ashanti et de Brong Ahafo du Ghana: Une etude de la competence technique indigene d'agriculteurs et les pratiques de la lutte.* Au Ghana l'igname est tres important en tant que culture de rapport et culture vivriere Indigene qui a attaint recemment la place d'une culture vivriere d'exportation non-traditionnelle la plus populaire malgre des annees d'abandon scientifique. Il y a une disette generale d'information technique sur la production d'igname et des contraintes de commercialization, surtout sur les ravageurs et la lutte contre eux. Pour comprendre et documenter les besoins d'agriculteurs comme un eventual point de depart pour le developpement de technologies pour satisfaire leurs besoins, un sondage etait entrepris de la competence technique indigene d'agriculteurs d'igname au sujet de ravageurs sur leurs cultures et leurs pratiques de la lutte contre les ravageurs pendant des annees en deux districts de Brong Ahafo et en un district d'Ashanti. Les questionnaires mises a l'essai etaient administres aux 30 agriculteurs selectionnes au hazard de cinq villages de chaque district. Les resultats revelent que la connaissance d'agriculteurs au sujet de ravageurs et d'echatillons de ravageurs etait semblable pour les trois districts. Les agriculteurs savaient que les insects ravageurs existaient sur leurs ignames mais ils n'ont pas pu etablir ni les rapports entre les populations de ravageurs et les ravages de pratiques culturaux qu'ils emploient ni l'etat ecologique de leurs champs. Les termites (*Amitermes* spp., *Macrotemes* spp. et *Microtermes* spp.) etaient consideres les ravageurs plus importants que les mille-pattes (*Peridontoyge* spp.), les coleopteres de tubercule *(Heterolygus meles* et *Prionorcytes rufopiceus)*, les aleurodes *(Pseudococcus brevipes, Planococcus dioscorea* et *Ferrisia virgata),* et les coccides *(Aspidiotus destructor* et *Aspidiella hartii)* dans cet ordre-la. Sur les 12 varietes de l'igname blanc cultivees, "Pona" etait identifie d'etre le plus predispose a l'attaque de ravageurs et "Dentepruka" etait le moins

Original scientific paper. Received 15 Apr 04; revised 25 Sep 05.

predispose. Les facteurs anthropologiques tels que l'origine d'agriculteurs, la situation de residence officielle, le niveau d'education, l'age, la situation conjugale, l'effectif de la famille et le systeme de tenure agraire, on a decouvert, qu'ils ont joue des roles-cles dans les technologies adoptees dans la culture d'igname. Les implications de resultats des recherches, particulierement pour l'identification de variable experimentales appropriees pour generation et la passation de technologie pour ameliorer la productivite de la resource d'igname, sont discutees.

Introduction

Yams (*Dioscorea* spp. Poir), native to the West African sub-region (Coursey, 1967), are important staples in Ghana where they are cultivated in almost all the regions, except for the semi-arid Sudan Savanna zone and the dry Accra plains. However, the main cultivation areas are in the Forest-Savanna transition and the Guinea Savanna belts where rainfall above 1000 mm is recorded annually. Yams are cultivated as subsistence and commercial crops. They are eaten in various preparations and have very important sociocultural uses. In some parts of northern Ghana, the size of a man's yam farm is indicative of his wealth. In other areas, yams constitute a major component of the bride price for customary marriages. Yams are so important in the culture of Ghanaians that they are the only crops that have several tribes celebrating festivals on their first harvest. They rank second only to cassava among the root and tuber crops in volume of production, but they command better value by weight for weight and from the nutritional point of view (Bell, 1983). They are, therefore, ranked number one above all other root crops in importance to the national economy, and also play a crucial role in food security and poverty alleviation (Dapaah, 1994; NARSP, 1994).

In the last decade, efforts have aimed to diversify the export base through developing the non-traditional export crop sector. Yams have gained prominence as some of the most important non-traditional export crops (Asuming-Brempong, 1994), with Ghana ranked first in export of yams worldwide. Despite the importance of yam and the fact that it originates from the sub-region and has been cultivated in the country in the past several centuries, little research attention was paid to the crop until the National Agricultural Research Project (NARP) was established in the early 1990s.

Several problems hinder efforts to produce yams in desirable quantities (Nutsugah *et al*., 2001; Tetteh & Saakwa, 1994). Important among these problems are declining soil fertility, drudgery and labour-intensive cultural practices, low-yielding varieties, the ravages of pests and diseases and poor marketing facilities, especially storage and avenues for processing and adding value to the crop and, thus, low prices in peak harvest seasons.

Field pests attacking yam include yam tuber beetles (*Heterolygus meles* Bilb. and *Prionorcytes rufopiceus* Arrow), termites *(Amitermes* spp., *Macrotemes* spp., and *Microtermes* spp.), vine beetles (*Crioceris livida* [Dalm.] and *Lema amata* [Fab.]), and nematodes such as *Meloidogyne* spp. and *Scutella bradys* (Steiner & Lehew) (Jatala & Bridge, 1990; Missah & Peters, 2001). The storage pests include mealybugs (*Pseudococcus brevipes* [Ckll.], *Planococcus dioscorea*, and *Ferrisia virgata* James), scale insects (*Aspidiotus destructor* Signoret and *Aspidiella hartii* [Ckll.]) (Emehute *et al*., 1998), and vertebrate pests such as rats. These pests reduce productivity and quality and, thus, the profitability of the yam industry. They act either singly or together to cause sub-optimal yields and deterioration in storage (Emehute *et al*., 1998). The relative

importance of each of these pests depends on the yam cultivar, ecological zone, cropping system as well as field and storage management practices adopted (Emehute *et al*., 1998).

Although more recently, through renewed initiatives under the Root and Tuber Improvement Project (RTIP), the importance of yams has been acknowledged by the research systems, little sociological studies have been carried out to identify production, marketing and other constraints for research interventions. Similar information needs to be gathered for pests to facilitate research planning. After all these years of cultivating and evolving the crop, the farmers should have a wealth of technical knowledge that researchers need to tap into to start developing farmer-friendly production technologies.

The objective of this study was to record farmers' indigenous technical knowledge about pests and the remedial measures they apply. The information generated would form the basis for research to develop cheap, economically sustainable and environmentally friendly pest management technologies to minimize the effects of such pests on yam productivity.

Materials and methods

The field study was conducted in June 2000 in two districts (Wenchi and Atebubu) in the Brong Ahafo Region and one district (Ejura/ Sekyedumase) in the Ashanti Region. All the three districts fall under the Forest-Savanna transition vegetation zone of the country which forms the most important segment of the yam belt. The districts were selected based on discussions with regional agricultural administrators and extension specialists, who confirmed that the three districts covered the predominant yam-producing areas within the two regions. Farmers were selected through a combination of simple and systematic random sampling techniques. In each district, five villages were randomly selected from a list of the predominant yam-growing farming communities. Six farmers were then randomly selected from each village, giving a total of 30 farmers per district and a total of 90 respondents for the survey. A structured pre-tested questionnaire was then administered to these farmers and the results analyzed.

Results

Except for rare situations in which the names and emphasis on particular pests differed, the results did not differ between the two regions. The results are quite representative of yam production and pest management practices within the districts surveyed. They are, thus, presented generally for the farmers surveyed.

Social and demographic characteristics

The average yam farm size in the area studied was 3.2 acres as compared to 4.3 for other crops. Most (71.3%) farmers interviewed had cultivated yams since the last 10 years. About 12 per cent of the farmers had been cultivating yam since the last 20 years. The average age of a yam farmer was 48 years, and 34 per cent of yam farmers were above the age of 50 (Table 1). The average population of a yam farmer's household was 10 persons. Most (79.1%) yam farmers were settlers and 92.3 per cent were males. Few farmers (11%) had had basic education while 67 per cent were illiterate.

Varieties planted and pest infestation

Over 16 varieties of yams are cultivated in the area, of which "Akaba" and "Matches" are popular water yam varieties; the rest are white yams. Yam farmers were generally aware of insect pests on yams. Over 90 per cent of the 60 yam farmers interviewed indicated that they encountered insect pests in their farms. Most could also associate some pests with some varieties of yams. About 81 per cent of farmers thought that some varieties of yams were more susceptible to some yam pests than others. The remaining 19 per cent were unaware of any such relationship. "Pona" was adjudged the most susceptible to insect pest attack, with 32.4 per cent of farmers ranking it first (Table 2). Amongst

TABLE 1

Dynamics of Yam Farmers and Their Families in the Ashanti and Brong Ahafo Regions of Ghana

Age of farmers		*Family size*		*Experience in yam cultivation*	
Age group	*% of farmers in range*	*Size range*	*% of farmers in range*	*Experience (years)*	*% of farmers in range*
20 - 30	14.4	1 - 50	19.7	1 - 10	71.3
31- 40	22.3	6 - 10	45.1	11 - 20	11.5
41 - 50	28.9	11 - 15	25.3	21 - 30	12.6
51 - 60	14.4	> 16	9.9	>30	4.6
> 60	20.0				

the white yams, "Lilli" was ranked second to "Pona" in susceptibility to insect pests, while "Matches" was thought to be more susceptible to pest damage than "Akaba" among the water yams (Table 2). "Dentepruka" was thought to be least susceptible to pest attack. Termites (*Amitermes* spp., *Macrotemes* spp., and *Microtermes* spp.) were adjudged the most important insect pests on yams (Table 3). Mealybugs (*P. brevipes*, *P. dioscorea*, and *F. virgata*) were ranked second to termites and more important as pests than millipedes (*Peridontoyge* spp.); but on account of their rankings, they seemed to be equally important (Table 3). Scale insects (*A. destructor* and *A. hartii*), vine beetles (*C. livida* and *L. amata*), and tuber beetles (*H. meles* and *P. rufopiceus*) followed in that order of importance as pests. Caterpillars and crickets

TABLE 2

Farmers' Ranking of Yam Varieties Cultivated in the Ashanti and Brong Ahafo Regions of Ghana for Susceptibility to Insect Pest Damage

Yam variety	*Type of yam*	*% farmers ranking the variety as most susceptible*				
		1st	*2nd*	*3rd*	*4th*	*5th*
Lilli	White yam	14.1	13.4	13.2	11.4	5.6
Matches	Water yam	12.7	22.4	15.1	37.1	27.8
Pona	White yam	32.4	14.9	11.3	0.0	5.6
Labrokor	″	7.0	9.0	3.8	2.9	0.0
Dentepruka	″	1.4	4.5	3.8	2.9	0.0
Akaba	Water yam	5.6	1.5	20.8	11.4	16.7
Muchumudu	White yam	4.2	0.0	5.7	2.9	0.0
Yeji	″	1.4	0.0	0.0	0.0	5.6
Chirikumasi	″	1.4	0.0	0.0	0.0	0.0
Morinyia	″	2.8	1.5	0.0	2.9	0.0
Logbere	″	4.2	6.0	1.9	2.9	0.0
Asobayere	″	4.2	1.5	5.7	0.0	0.0
Nananto	″	0.0	1.5	0.0	5.7	0.0
Dokoba	″	0.0	4.5	0.0	2.9	0.0
Afebetua	″	0.0	1.5	0.0	0.0	0.0
Others	-	8.6	17.9	18.9	17.1	38.9

TABLE 3

Order of Ranking Insect Pests of Yams by Farmers in the Ashanti and Brong Ahafo Regions of Ghana

	% of farmers ranking it as				
Arthropod	*1st*	*2nd*	*3rd*	*4th*	*5th*
Termites	38.1	26.4	20.0	7.3	0.0
Mealybugs	20.2	11.1	13.3	14.6	11.8
Millipedes	13.1	27.8	28.3	26. 8	11.8
Vine beetles	7.1	12.5	3.3	17.1	11.8
Scale insects	11.9	15.3	21.7	29.1	41.2
Caterpillars	1.2	1.4	0.0	0.0	0.0
Tuber beetles	7.1	5.6	13.3	4.9	23.5
Crickets	1.2	0.0	0.0	0.0	0.0

(*Brachytrupes membranaceus* Drury) seemed not to be serious pests in the study area. Only few farmers reported them as pests (Table 3). It was surprising that yam tuber beetles were not considered serious pests in the area. It was only in the Atebubu area and the northern fringes of the Ejura District that some farmers recognized the tuber beetle as a pest of yams.

Source of planting material

Farmers either used their own planting materials or collected them from friends or the local market or both. Some 86.7 per cent of yam farmers relied on their own planting materials, while 11.1 and 2.2 per cent collected their planting materials from the market and friends, respectively.

Seed yams constituted 23.1 per cent of the planting materials farmers used, while use of small whole tubers and pieces of large tubers as planting material was equally important (11.5%). Yam farmers also used combinations of planting materials. The combined use of small tubers and pieces cut from large tubers was the most popular practice among farmers. The type of planting material used varied with type of yam. For those yams that are amenable to 'milking', seed yam was the most important source of planting material. For water yams that are only harvested once a year, the use of small whole tubers and pieces of large tubers was more popular. Most yam farmers thought that planting material had no effect on the incidence of pests on the farm. About 20.2 per cent could attribute pest problems on their farms to their source of planting material. Only 20 per cent of the farmers thought that planting material could affect the population of insect pests on yams, while 46 per cent opined that planting material was inconsequential in pest attack on yams. The remaining 34 per cent of the farmers could not draw any relationships between planting materials and pest problems.

Cultural practices and incidence of insect pests

Cultural practices such as weeding, mulching and staking were commonly practised among yam farmers in all the three districts. As many as 92.2 per cent of farmers mulched their yams. Only 7.8 per cent did not carry out the practice. For those who mulched their yams, 80.5 per cent did so at planting, 13.8 per cent mulched after planting, and 5.7 per cent mulched before planting (Table 4). Most farmers (56.3%) mulched with leaves, but 42.5 per cent used weed stubble left on the field at mound preparation, and 1.1 per cent used yam vines (Table 4).

All farmers weeded their farms several times before the harvest of yams. About 89.7 per cent of the farmers interviewed indicated that they weeded their farms at least three times before harvest (Table 5). The most common weeds encountered on yam farms were the grasses (66.3%), with the broadleaved weeds (30.3%) ranking second (Table 5). Shrubs were generally of low significance (2.2%) (Table 5). Despite this clear weed pressure on yams, only 33.7 per cent of the farmers thought that weeds affected incidence of pests on the farm. Among this group of farmers, 90.3 per cent (Table 6) thought the effect would be due to an increase in insect populations and the damage that they caused. Again, 14.5 and 17.1 per cent thought weeds increased the populations and damage of

TABLE 4

Time of Mulching and Mulching Materials Used by Yam Farmers in Ashanti and Brong Ahafo Regions of Ghana

Time of mulching		*Mulching materials*	
Time	*% of farmers involved*	*Materials*	*% of farmers using material*
Before planting	5.7	Leaves	56.3
At planting	80.5	Grass stubble	42.5
After planting	13.8	Dead yam vines	1.1

TABLE 5

Weed Types Found in Yam Farms in Ashanti and Brong Ahafo Regions and Frequency of Weeding

Common weeds		*Frequency of weeding*	
Weed designation	*% of farmers reporting it on farm*	*No. of weedings*	*% of farmers who practise it*
Grasses	66.3	1	2.2
Broadleaved herbs	30.3	2	8.1
Shrubs	2.2	3	60.9
Others	1.1	>3	28.8

TABLE 6

Effect of Weeds on the Incidence of Insect Pests on Yams in Ashanti and Brong Ahafo Regions of Ghana

Perceived effect	*% of respondents holding perception*
Increases	90.3
Decreases	6.5
Can't tell	3.2

millipedes and termites, respectively (Table 7). Only 8.1 per cent of farmers associated increased yam tuber beetle populations and damage with increased weed density of yam fields. Most (38.7%) farmers could not establish any relationship between weed densities and the population and damage of any particular insect pest. Few (13.9%) yam farmers were of the opinion that weedy yam fields could result in increased populations and damage of all insect pests (Table 7).

Generally, farmers stake their yams in the study area, with as many as 95.6 per cent of them adopting the practice. About 23.9 per cent of the farmers who staked yams could establish a relationship between staking and pest incidence. As many as 71.6 per cent intimated that staking did not affect the pest population and damage on yams (Table 8). For those who thought staking influenced the incidence of pests on yams, equal proportions (18.8%) thought that it caused an increase or a decrease, while 16.7 per cent were unable to draw any relationship (Table 8).

Control of insect pests

Despite the general awareness of farmers about insect pests on yams, only 26 per cent ever attempted any control of these pests. About 51.9 per cent of the farmers who attempted to control pests on their yams dipped their seed yams and other planting materials in pesticide solutions before planting, 28.0 per cent applied chemical pesticides after planting, while 31.9 per cent used a combination of these

TABLE 7

Farmers' Perception of the Effect of Weeds on Increasing Incidence of Some Insect Pests on Yams

Arthropod	*% of farmers attributing incidence to weeds*
Termites	17.1
Millipedes	14.5
Tuber beetles	8.1
Mealybugs	1.6
All insects	13.9
None at all	4.8
Can't tell	40.0

TABLE 8

Farmers' Knowledge About the Effects of Staking on Incidence of Insect Pests and Pest Damage to Yams

Knowledge base of farmers on staking	*% of farmers**	*Perceived effects of staking on pest damage*	*% of farmers holding perception*
Farmers staking	95.6	Increases	18.8
Certain about effects of staking	23.9	Decreases	18.8
Uncertain about effects of staking	71.6	Can't tell	62.5

* Percentage total more than 100 because of multiple responses

measures (Table 9). About 4.1 per cent of the farmers used wood ash applied at planting to control pests, and an equal proportion (4.1%) tried to avoid insect damage by planting early (Table 9). For those who controlled pests, 51.9 per cent indicated that their control measures were quite effective, 8.0 per cent found their measures ineffective, and 12.1 per cent could not tell whether their measures were effective, while 28 per cent said their control measures were only partially effective (Table 10).

Discussion

The results of demographic information about yam farmers in the study area show that yam farmers in Ashanti and Brong Ahafo regions are mostly settler farmers with low standard of education. It was also indicated that yam farming is a male-dominated job, probably because of the physical nature of all the cultural practices involved. The drudgery and cost of labour probably explain the relatively large family sizes, although family size may also reflect the farmer's prosperity. The drudgery and high labour input and cost required of yam farming may also explain the low level of female participation. But despite similar labour requirements and costs, female participation in yam production in western Nigeria has increased recently as a result of increasing economic returns (Manyong, Asiedu & Olaniyan, 2001).

Most yam farmers were above the age of 50 (Table 1), indicating a serious problem that is looming over yam farming. Unless efforts are made to entice the youth into yam farming or to reduce the physically demanding cultural practices associated with yam cultivation, it may be difficult for the aged farmers to continue to meet the yam production targets of Ghana.

TABLE 9

Methods of Pest Control Used by Yam Farmers and Their Perceived Effectiveness in the Ashanti and Brong Ahafo Regions of Ghana

Method of pest control	*% of farmers adopting practice**
Dip seed yams in insecticides before planting	51.9
Spray insecticide after planting	28.0
Early planting of yams	4.1
Apply wood ash at planting	4.1
Others (combination of methods)	31.9

* Percentage total over 100 because of multiple responses

TABLE 10

Farmers' Perception of the Effectiveness of Their Pest Control Practices

Perception of efficacy	*% of farmers holding the view*
Very effective	51.9
Partially effective	28.0
Not effective	8.0
Can't tell	12.1

Manyong *et al*. (2001) made similar observations and recommendations when they studied the resource management constraints of farmers in western Nigeria.

If the land areas devoted to yams and other crops are compared, it is noted that yams are important crops as already stated by other workers (Dapaah, 1994; Manyong *et al*., 2001; NARSP, 1994). This may be because the survey targeted yam farmers who considered yam as a major commercial crop. Also, the need to raise mounds for yams means that more land area may be required for a relatively small population of yams. However, the size of the yam farm could be limited by the availability and price of suitable land, because yams require well-drained fertile soils and are still cultivated once in a 3 to 5-year fallow period on a piece of land. The size of yam farms may also be limited by availability of planting material, extensive labour requirement, and other resources such as mulching materials and stakes needed to cultivate yam profitably. The need is to find suitable alternative cultivation practices that are less physical for the profitable cultivation of yams.

Despite the overwhelming desire for innovations to solve farmers' cultivation problems, it is probable that their low educational standard, large family sizes and settler status (which affects land tenure arrangements) could hinder the adoption of technologies involving major investments. In western Nigeria where land is still abundant, yam farmers practise shifting cultivation to solve some resource management problems (Manyong *et al*., 2001). Unlike the situation in western Nigeria, land suitable for yam cultivation in the three districts studied is quite scarce and in high demand. Consequently, shifting cultivation is no longer a practical solution to land and other resource management problems of farmers.

The results also indicated that most yam farmers in the study area knew that insects were on their yams. They were, however, unable to determine the immediate impact the insects associated with their yams had on the crop. Also, only few farmers associated various insects with the weather, and most did not know the exact relationship between the farm environment and insect populations. Practices such as mulching, staking and weeding seemed to be part of yam cultivation routine that had to be followed to the letter, without any regard for their effects on productivity of the crop. Therefore, farmers did not relate these practices with populations of organisms associated with yams. This attitude could contribute to the inability to associate important ecological factors, such as weed densities on their farms and types of weeds, with insects. It was, for example, surprising that although most yam farmers thought that termites were the most important pest species on yam farms, some continued to use grass stubble to mulch their yams. The predominant use of stubble mulch also presupposes that grass stubble is left on the farm and would serve as a good source of food and refuge for termites. Yam farmers in other areas where yams are cultivated across Africa face similar problems of pests and diseases on their yams; and invariably, as for yam farmers in this study area, they have no solution to this constraint (Acquah & Evange, 1994; Kapinga *et al*., 2001; Manyong *et al*., 2001).

Farmers showed a general lack of competence in ranking varieties of yams for susceptibility to insects, and in ranking insects for importance as yam pests. Detailed research involving characterizing yams for pest resistance across the sub-region, and ranking insects associated with yams as pests would be necessary to facilitate further research and standardization of pest management approaches. If such information were available to farmers, it would help them to select and cultivate only varieties that are most suited for the pest stresses in their localities.

The results also indicated that contrary to earlier expectations, termites, mealybugs and millipedes, rather than yam tuber beetle, were the most important insect pests on yams in the study area. "Pona" was ranked the most susceptible

yam variety to most insect pests recorded (Table 2). This suggests that it is under serious threat of extinction, unless serious efforts are made to mitigate the ravages of pests on it.

Farmers also had little understanding of the relationships between planting materials, their sources and the pest activity on the resultant crop. They were generally ignorant about the effects of types of weeds, weed density, and other ecological factors in the farm on the activities of insect pests. These areas need to be investigated to establish the necessary relationships to facilitate the development of effective strategies for managing pests. Invariably, pest management was limited to dipping plant materials in pesticide solutions before or at planting. Investigations that will show safer and more effective pesticides and methods for applying pesticides are necessary to boost continued, profitable yam production. Furthermore, because farmers were not well informed about the role of cultural practices such as staking, mulching and weeding on pest populations and their damage to the crop, it would be necessary to investigate them; or to disseminate technologies, where available, to assist the effort to develop strategies for managing pests.

Acknowledgement

The authors are very grateful to the Coordinator of the Root and Tuber Improvement Programme, Ministry of Food and Agriculture (RTIP-MOFA) and the Project Coordination Unit (RTIP) for providing financial support for the work; and to the Director, CSIR-Crops Research Institute for permission to publish the results.

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