CHAPTER I

INTRODUCTION

Sweet potato, Ipomoea batatas (L.) Lam, a carbohydrate producing root crop, ranking seventh in world production after wheat, rice, maize, potato, barley, and cassava (FAO 1990), is a staple food in many parts of the tropics (Yen 1974, Onwueme 1978, Villareal 1982, Bouwkamp 1985, FAO 1986, Nwinyi 1987). Worldwide, it supplies 3.9 % of the caloric intake and 1.7 % of the protein for human consumption (FAO 1986). In certain parts of the tropics, where this crop is the only staple food, sweet potato contributes approximately 80 % to 90 % of the caloric intake of the population. This situation, for example, occurs in the central highlands of the the island of New Guinea, which includes Papua New Guinea (Bourke 1985, FAO 1986, Hadfield 1989) and the Irian Jaya province of Indonesia (Oomen et al. 1961, Ruinard 1969, Oomen 1971, Manwan & Dimyati 1989, Karafir 1989). It is also the staple food in several South Pacific Islands, including the Solomon Islands and Tonga (Onwueme 1978, Bradbury & Holloway 1988, Horton & Ewell 1991), in the Visayas region of the Philippines (Villareal 1982, Palomar et al. 1989, MacKay 1989), in some African countries, including Rwanda (Janssens 1982, Alvarez 1987, Horton & Ewell 1991), the Cameroons (Pfeiffer 1982), Burundi and parts of Uganda (Alverez 1987), and in parts of the Carribean (Horton & Ewell 1991), especially during drought periods (Bouwkamp 1985).

In addition to human food, sweet potato plays a significant rôle as animal feed, and as the raw material of industrial starch and alcohol production (Edmond & Ammerman 1971, Yen 1974, Hahn 1977, FAO 1986, Jansson & Raman 1991).

In Irian Jaya, the indigenous people have cultivated sweet potato since the crop was first introduced to the island of New Guinea in the 14th century (Yen 1974). Since then, sweet potato has become an important staple food of the indigenous people, and of at least one livestock species (the pig) in the central highland region of the island (Rappaport 1984, Halfield 1989). Thus, based on its role and importance as human food and animal feed, sweet potato remains central to the agricultural system in Irian Jaya (Karafir 1989).

Today it is planted extensively, both in lowland and highland regions, by various local tribes, each employing its own cropping system. In the lowlands the crop is planted in a mixture with other crops such as corn, taro, tannia, cassava, sugar cane, cucumber, banana, and Hibiscus manihot, whereas in areas of cleared virgin or secondary forest it is planted under a shifting cultivation system (Karafir 1989). It is also commonly planted in gardens adjacent to houses and villages. In the highlands, sweet potato is planted in fields in the valleys and on hill sides, either as a monoculture, or mixed with corn, taro, beans, cabbage, tomato and sugar cane (Figs.1-4.)

Although sweet potato has been cultivated for many years, the yield level is usually low: less than three tons per hectare in the lowlands (Ruinard 1969), to three to six tons per hectare in the highlands (Pospisil 1963). Recent data (Karafir 1989), however, indicate that sweet potato production in Irian Jaya has increased to an average of seven tons per hectare.

Fig. 1. Sweet potato intercropped with corn in Kamu valley of the western highland region of Irian Jaya, Indonesia.

Fig. 2. Sweet potato grown intercropped with corn, bean, cabbage in Baliem valley of the eastern highland region of Irian Jaya, Indonesia.

Fig. 3. Sweet potato grown intercropped with sugar cane, tomato and cabbage in Baliem valley of the eastern highland region of Irian Jaya, Indonesia.

Fig. 4. Sweet potato growth with taro in Baliem valley of the eastern highland region of Irian Jaya, Indonesia.

This level of production is still only 50 % of average world yield data, which is 14 t/ha (Horton 1988, 1989). As a consequence, production of sweet potato in Irian Jaya is sometimes insufficient to meet the needs of both humans and livestock. For example, the consumption of sweet potato in the eastern highland region of Irian Jaya in 1985 (359 tons) exceeded the production of sweet potato (230 tons) by 56 %. Such production shortfalls (Karafir 1989) have sometimes been followed by local famine (Oomen et al. 1961).

Several factors limit production of sweet potato in Irian Jaya. These include low soil fertility, a long dry season, the use of low yielding varieties, poor management of cultivation techniques, and little or no attempts at pest control.

Among the 16 main insect pests of sweet potato in Irian Jaya (Table 1; Simon Thomas 1962), the sweet potato weevil (SPW), Cylas formicarius (F.) (Figure 5), is the most economically important pest (Szent-Ivany 1958, van Driest & Ruinard 1960, Lamb 1974). It damages the sweet potato vine and tuber, and occasionally the foliage, thereby reducing both the yield and quality of the crop (Sutherland 1986[a]).

Fig. 5. Adult sweet potato weevil, *Cylas formicarius* (F.) (Coleoptera: Curculionidae). (Dr. G.V.H. Jackson, South Pacific Commision, Noumea).

Table 1. Insect pests of sweet potato in Irian Jaya

Classification	Insect species	Part attacked[1]
Coleoptera:		
Curculionidae	Cylas formicarius (F.)	S,L,T
	Oribius improvidus Mshl.	L
Coccinellidae	Epilachna signatipennis Boisd.	L
Chrysomelidae	Meroleptus cinctor Mshl.	S
	Aspidomorpha adhaerens Weber	L
	A. australasiae Boisd.	L
	A. punctum F.	L
	Cassida diomma Boisd.	L
	C. holmgreni multicolor Blackb.	L
	C. papuana Speath	L
	C. strigula F.	L
	Laccoptera impressa Blanch	L
Lepidoptera:		
Nymphalidae	Appias melania F.	L
	Precis orithya F.	L
	P. villida Bod.	L
Sphingidae	Herse convolvuli L.	L

Source: Simon Thomas 1962. [1)] S = stem; L = leaf; T = tuber

The following control methods have been proposed to reduce yield loss caused by insects: resistant cultivars (Mullen et al. 1985, AVRDC 1987,1988), cultural techniques such as crop rotation (Reinhard 1923, Gonzalez 1925, Cockerham et al. 1954, Sherman & Tamashiro 1954, Kalshoven 1981, AVRDC 1986, 1987, 1988), removal of volunteer plants and crop debris from harvested fields (Reinhard 1923, Gonzales 1925, Cockerham et al. 1954), prompt harvesting (Sherman & Tamashiro, 1954, Sutherland 1986[a]), removal of alternative wild hosts (Cockerham et al. 1954, Talekar 1983, AVRDC 1988), planting away from weevil-infected fields (Sherman & Tamashiro 1954, AVRDC 1988), intercropping (Singh et al. 1984, AVRDC 1987), and maintaining soil to avoid cracking through banking and irrigation (Pardales & Cerna 1987, Talekar 1987). Chemical control with insecticides (Sherman & Tamashiro 1954, Wolfenbarger & Walker 1974, Muruvanda 1985, Schalk & Jones 1985, AVRDC 1987), and a synthetic sex pheromone (Proshold et al. 1986) have also been proposed. Often these methods are combined in an integrated pest management strategy (Talekar 1988, 1991). Recent developments include the use of natural control agents such as predators, parasitoids, entomopathogenic fungi, bacteria, and nematodes (Jansson 1991[a]). Among these agents, two entomopathogenic nematodes, Heterorhabditis bacteriophora strain 'HP88", and Steinernema carpocapsae strain "All", are promising as biological control agents of SPW (Jansson 1991[b]).

Based on the agricultural system in Irian Jaya, the farmers' ability, availability of control agents and economic limitations, control of the SPW by cultural techniques is considered to be the most appropriate approach, and the one most likely to be adopted at the present time.

Application of these control measures, however, should not be applied directly without taking into account the traditional agricultural systems employed by the farmers (Jansson & Raman 1991). Modification of certain cultural techniques would be useful and appropriate as such modifications would not dramatically change the farmers' production system. Moreover, the modification of production techniques does not usually require additional inputs or further knowledge of cultivation techniques, although it may require a better understanding of the insect and the factors responsible for its pest status (Jansson & Raman 1991).

Intercropping sweet potato with one or more crops is one of the cultural techniques that is already widely practiced in Irian Jaya (Karafir 1989). Generally, this practice increases crop diversity, which provides both barriers to pest dispersal and more habitats for natural enemies, thereby reducing both colonization of the crop by pests and their subsequent control (Litsinger & Moody 1976, Perrin 1977, Hare 1983, Andow 1983, Altieri & Liebman 1986, Altieri 1987, Risch 1987).

The significance of intercropping in the control of SPW, however, is poorly understood (O'Hair 1991). Preliminary data that are available from India (Singh et al. 1984) and Taiwan (AVRDC 1987) indicate that intercropping alone is insufficient for controlling SPW, and that the level of control varies with the intercrop species that is used. For example, intercropping sweet potato with proso-millet and sesame in India reduced infestation by SPW to 9 % and 6 %, respectively, compared with 28 % in sweet potato monoculture (Singh et al. 1984). Similarly, in Taiwan, intercropping sweet potato with chickpea, coriander, pumpkin, radish, fennel, blackgram or yardlong bean also significantly reduced the level of infestation (AVRDC 1987). When sweet potato was intercropped with a number of other crops, such as green gram (Singh et al. 1984, AVRDC 1987), cabbage, peanut, and corn (AVRDC 1987), reduction in infestation by the SPW to 12 % from 20 % was still considered to be unacceptable. The extent to which intercropping can reduce infestation of the sweet potato by SPW and other insect pests in Irian Jaya was unknown prior to the present research.

In an attempt to obtain an appropiate method for controlling SPW among traditional sweet potato farmers in Irian Jaya, this research program was designed to determine (1), the effectiveness of intercropping of sweet potato with corn, soybean, tomato and cabbage in reducing crop damage, (2), the population density of SPW at harvest, and (3), the diversity of insects and other arthropods in sweet potato agroecosystems.

Because this research was designed to be supportive of small scale sweet potato farmers, the intercropping systems tested were chosen in relation to the farmers' traditional practices.