Smallholder farmers' knowledge of coffee pests and diseases in Eastern Highlands Province, Papua New Guinea

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ABSTRACT

Smallholder levels of knowledge of pests and diseases of coffee were assessed at four different sites in three districts of Eastern Highlands Province, Papua New Guinea, from 2010 to 2012. Data were collected during interviews with farmers in their coffee gardens following physical inspection of their gardens. Additional data were collected through interviews with the families of farmers at their homes. The interviews elicited levels of individual knowledge and opinions of coffee pest and disease management. The main issue identified was the lack of knowledge of cultural control of pests and diseases resulting in heavy field infestations. The very low level of knowledge of pest and disease control methods would suggest that the Coffee Berry Borer, which arrived recently in the PNG highlands, is likely to be very difficult to contain.

KEYWORDS: farmers' technical knowledge, smallholder, pest and disease control

INTRODUCTION

Smallholder farmers' knowledge of coffee pests and diseases, and how that knowledge relates to field infestation levels and pest management practices were assessed through an interview survey conducted at four different sites in Eastern Highlands Province (EHP), Papua New Guinea (PNG). The four sites were categorized into accessible and remote sites. Accessible sites were characterised by good infrastructure and easy access to markets whereas remote sites were places with difficulties in transportation and poor market access.

The data for this paper are extracted from the survey questions focusing mainly on the knowledge of smallholder farmers on pests and diseases of coffee. The questions focused on green scale (*Coccus celatus* and *Coccus viridis*); pink disease (*Corticium salmonicolor*) and coffee leaf rust (*Hemileia vastatrix*) and whether or not the management of shade in the farmers' coffee gardens would affect infestation levels of these pests and diseases.

Pests and diseases are among the biggest problems that coffee farmers face, causing enormous crop losses, and consequently taking a large bite out of farmers' incomes and food purchases. Controlling pests and diseases is not easy, and farmers require a variety of strategies to control them, but they need the knowledge to do this. With the appropriate knowledge, they can recognise early signs of a problem, and decide on the best means of treatment.

Smallholder coffee producers depend on coffee income to meet commitments such as school fees and customary obligations. They harvest coffee to meet specific cash needs when these arise and so cannot be considered to be full-time producers like those operating plantations. As a consequence, they invest very little time, labour or

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money in coffee garden maintenance and long-term management such as agronomic practices and pest and disease control (Curry et al. 2017).

Pest and disease control is necessary to increase coffee production. However, as it will be argued in this paper, while farmers know that pests and diseases contribute to crop losses, they have very poor knowledge of coffee pests and diseases and appropriate control methods. The survey reported on in this paper was carried out to assess farmers' perception regarding the use of shade trees in coffee in controlling pests and diseases.

This paper begins with a review of the literature on the problem of pests and diseases in coffee associated with shade levels. Then the methods used to carry out the survey are discussed, followed by the results and discussion.

LITERATURE REVIEW

Studies show that cultural control through shade management as well as thinning the coffee trees after harvesting, coupled with sanitary harvesting have been successful in reducing pest and disease infestation levels (Singh, 1995; Ramachandran et al. 1998). High shade levels and the accompanying increase in humidity and reduction in temperature affect both the insect pests and their predators and disease organisms (Singh, 1995). Many parasitoids exhibit greater host-searching capacity under unshaded conditions, enhancing their effectiveness as natural bio-control agents. On the other hand, entomopathogenic fungi may be more efficient as bio-control agents under conditions of increased shade and humidity (Singh, 1995).

Atmospheric humidity, and consequently the surface wetness of plants, are increased under shade. High humidity triggers the release of fungal spores in many species and free moisture is required for spore germination. This explains reported increases of disease incidence at the tree-crop interface and in very dense plant stands (Ramachandran et al. 1998). Fungal and bacterial pathogens grow best at moderate temperature and high humidity, which are both provided by a dense shade canopy.

The definition of the optimum shade intensity for a crop is particularly difficult when several important diseases differ in their response to shade. This is the case in coffee. High humidity caused by excessive shade favours the development of several fungal coffee diseases, including leafspot (***Mycena citricolor***), pink disease, thread blight (***Pellicularia koleroga***, syn. ***Corticium koleroga***) and ***Marasmius*** spp (Cambrony, 1989; Beer et al. 1998). For coffee leaf rust, increased incidence under intensive shade has also been suggested (Guharay et al. 1999), although this disease affects coffee under both shaded and unshaded conditions (Beer et al. 1998).

An important principle is to manage shade for minimising physiological stress of the crops themselves (e.g. to avoid excessive irradiation, too high or low temperatures, drought stress), thereby increasing their resistance to pest and disease attack. Optimum shade usually has a range which is sufficiently wide to accommodate seasonal and year-to-year fluctuations of weather conditions. However, even if the overall shade level of a plot is in the optimum range, pathogens may develop in micro-niches of high humidity which are created by patches of denser shade, and these may subsequently act as inoculum sources. It seems likely that, from a phytopathological view, homogeneous, intermediate shade is more favourable than a patchwork of heavily shaded and unshaded spots, although this requires confirmation. The type of shade depends very much on the shade tree species and its management (Ramachandran et al. 1998).

Most smallholder coffee is grown under medium to heavy shade resulting in lower annual yields because of heavy pest and disease infestation in the field. The most common way to manage shade is by coffee pruning, shade pruning and weeding. The literature reveals that knowledge of these concepts, in general, appears to be limited and poor knowledge of pests and diseases can be detected (Ramachandran et al. 1998; Guharay et al. 1999).

Research on coffee green scale, pink disease and leaf rust in PNG was carried out in the 1960s, 1980s, and early 1990s (Shaw, 1962; Tomlinson, 1996; Apety and Arima, 1998). These studies revealed at the time that farmers were not aware of pests and diseases of coffee or how to control them.

EVALUATION OF PAST RESEARCH IN PAPUA NEW GUINEA

Coffee green scale

Apety and Arima (1998) carried out a shade trial on coffee green scale development to assess the influence of shade on green scale populations. They revealed that coffee grown under more than 50% shade had less coffee green scale than coffee grown in unshaded open fields. Therefore, shade control is critical in reducing infestation levels of green scale in coffee gardens.

Pink disease

Research of pink disease in PNG was carried out in the early 1960s by the Department of Agriculture and Livestock (DAL). According to Shaw (1962), reduction in pink disease infestation levels is achieved through proper shade management and good agronomic practices. In addition, their study showed that coffee pruning also provides an obvious and immediate decrease in disease incidence (Shaw, 1962).

Coffee leaf rust

An outbreak of coffee leaf rust (CLR) in PNG was reported in 1986 (Tomlinson, 1996). The effects of CLR in PNG have so far been far less serious than predicted in 1986 (Shaw et al. 1986). This has been attributed to sub-optimal mean minimum temperatures in the main coffee growing areas of the country (Brown et al. 1995a; Brown et al. 1995b) at altitudes above 1600 m.a.s.l.. Generally, shade levels also have an impact on the incidence and severity of CLR (Shaw, 1962). A moist environment is favourable for the development and spread of fungal spores.

MATERIALS AND METHODS

Site selection

The study was conducted in EHP, PNG. For this study a sample of 100 households was selected randomly at each of the four study sites: Asaro, Bena, Baira and Marawaka (Figure 1). A detailed description of the methods is provided in Curry et al. (2017).

The four (4) sites were selected according to their level of accessibility. Asaro and Bena had relatively high levels of market accessibility to Goroka while Baira and Marawaka were remote sites without road access (Figure 1). Within the selected sites, the farmers were also selected according to their participation in Coffee Industry Corporation (CIC) facilitated training. Asaro and Bena had farmer groups involved with CIC; at Baira a farmer group was involved with a coffee exporter; and Marawaka had no group associations with the Coffee Industry.

Household selection

Households were randomly selected with the assistance of farmer groups and village leaders who provided village household records. Farmers' participation was voluntary, therefore, farmers who were not interested were removed from the list and did not participate in the study.

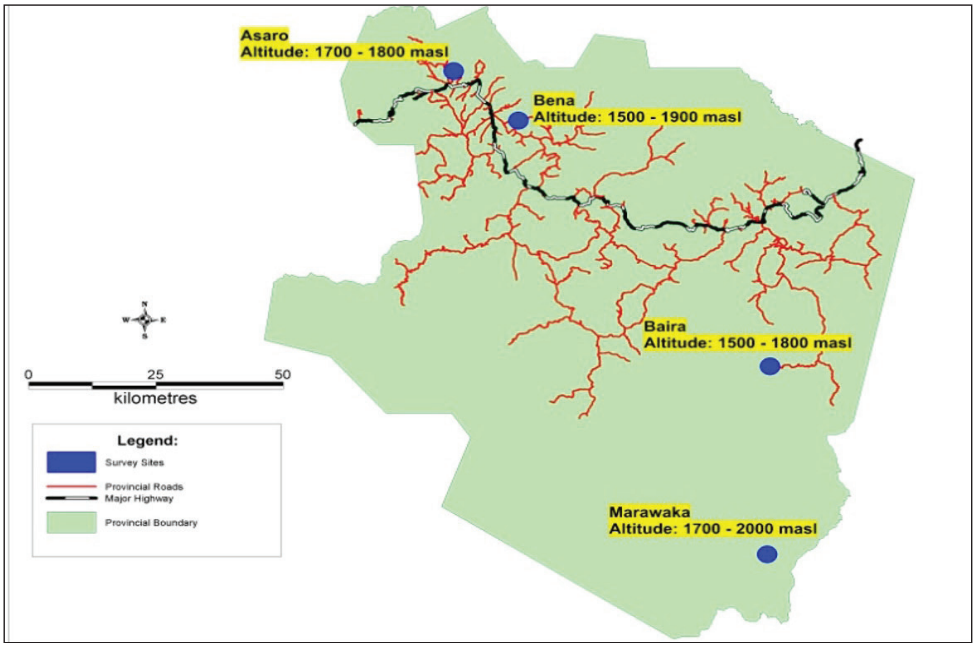

Figure 1: Map showing study sites.

Baseline survey

This involved a large-scale survey with one-on-one interviews with participating households. The survey approach used both qualitative and quantitative techniques. The baseline data were collected on households via interviews with household heads (i.e. husband and wife, or in the absence of the husband, the wife was interviewed). The survey covered the demographic structure of the household, ownership of land and coffee farms, labour and time allocation activities, income earning activities, wealth and ownership of capital and level of contact with extension services (Curry et al. this issue; Koczberski et al. this issue). Additionally, the farmer's house location was also recorded using a hand-held GPS unit, while the garden was physically inspected for soil management activities, coffee management practices and levels and types of weeds, pests and diseases (Kiup et al. this issue).

This paper draws on data from a portion of the survey covering farmers' knowledge of the effects of shade on coffee pest and disease infestation levels.

RESULTS AND DISCUSSION

Much of the information collected showed that farmers in the remote sites of Baira and Marawaka lacked knowledge of coffee pest and disease cultural control methods (Figure 2). Less than 20% of farmers interviewed responded correctly by stating that pest and disease levels would decrease if shade levels were reduced. More than 60% of respondents were not sure of the answer. Farmers in remote sites have difficulty accessing information on pests and diseases as they are constrained by poor rural infrastructure such as roads and bridges. Also, poor accessibility means that it is more difficult and costly to deliver extension services to these farmers. This is the main reason why many farmers interviewed were uncertain of the pest and disease situation despite pruning their shade trees.

Farmers in remote sites displayed interest in adopting technology to control pests and diseases, however, awareness is lacking in this area. Moreover, geographical isolation is one of the major constraints limiting delivery of basic

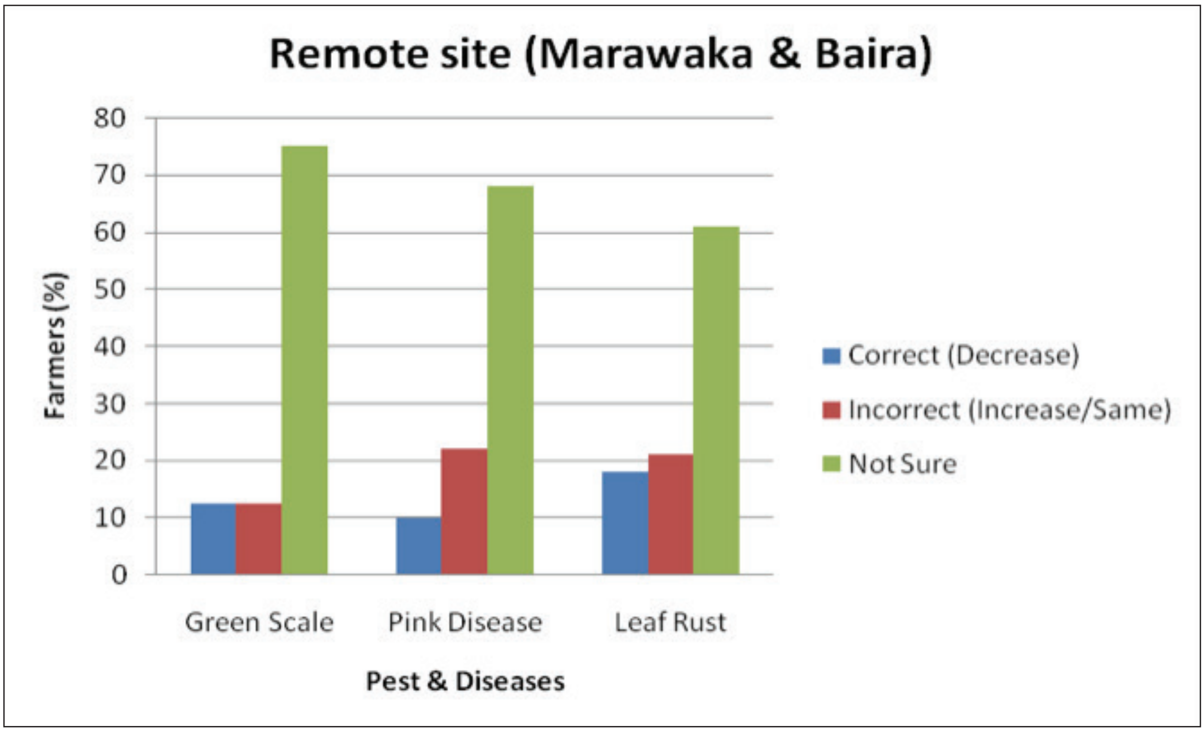

Figure 2: Responses from the farmers at remote sites (Marawaka and Baira) to the question: 'If shade levels are reduced in the coffee garden, what will happen to the existing pest and disease situation?'

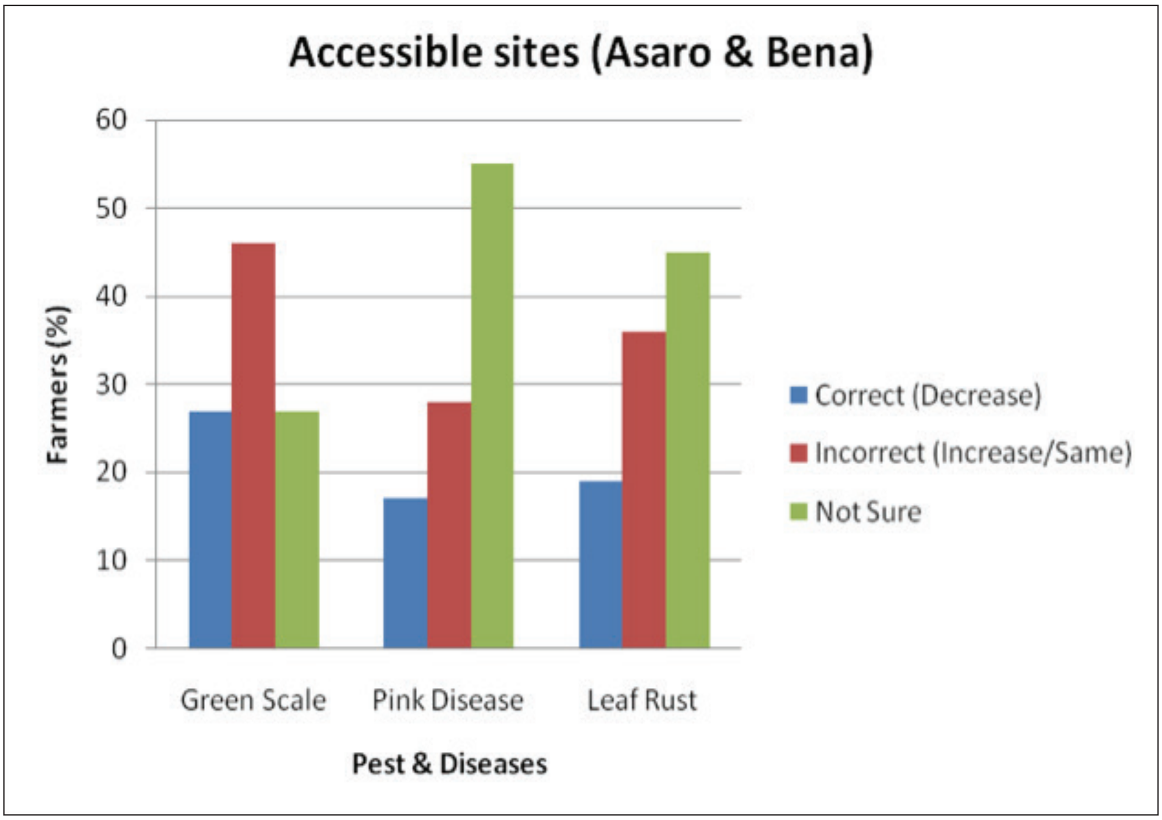

Figure 3: Responses from the farmers at accessible sites (Bena & Asaro) to the question: 'If shade levels are reduced in the coffee garden, what will happen to the existing pest and disease situation?'

government services like extension in remote villages. Extension services, like training in pest and disease management, were not reaching the remote sites. Physical inspection of coffee gardens revealed heavy infestations due to over-shading.

From the total of 195 farmers interviewed in accessible sites, 28% of them identified correctly the relationship between green scale and shade level (Figure 3). However, another 28% of the famers were not sure of the pest and disease situation whilst 44% of the respondents answered incorrectly.

Less than 20% of farmers gave the correct answers for pink disease and CLR. Fifty-five and 45% of farmers were not sure of the effect of shade on pink disease and CLR respectively. A large proportion of the farmers in accessible sites were uncertain of the pest and disease situation in their gardens.

Farmers' accessibility to service centres is relatively easy in accessible sites. They have good access to information on pests and diseases and as such their knowledge levels are slightly higher than farmers in remote sites. However, overall knowledge levels of farmers in both remote and accessible locations are poor. This suggests that there is lack of extension to these accessible sites or the extension training was inadequate to address these problems.

From comparisons between sites, accessible site farmers were advantaged with better access to information whilst remote farmers were at a disadvantage in accessing information. Overall, however, the results from this survey reveal that farmers in both remote and accessible sites were not aware of pest and disease cultural control technologies.

Other practices

Another important finding was that farmers in accessible sites were more engaged in the production and marketing of vegetable crops and rearing of livestock like goats and pigs (Inu 2015; Curry et al. 2019). As such, less time was given to coffee management and general coffee garden maintenance than at remote sites. For example, levels of weeding were poor in accessible sites thus providing a moist and favourable environment for pests and diseases to multiply and spread.

The common trend in accessible sites is for farmers to neglect their coffee during the off-season and spend more time in vegetable production. Farmers reported that their income from coffee was less than that earned from vegetable production. They can earn twice or thrice the amount of income from vegetables than from coffee. Therefore, more time and resources are invested in vegetable production than coffee.

The situation in remote sites is different. Because of poor accessibility to markets, the ability to earn income from other sources like vegetable production is not possible, so farmers in inaccessible areas are willing to put more labour into coffee farming.

CONCLUSION

The findings have shown that farmers in the four sites managed to produce coffee over decades with minimal supervision and guidance from agricultural extension services. Farmers in remote sites were constrained by a lack of knowledge about pests and diseases and their control whilst farmers in accessible sites had more diverse incomes from sources such as vegetable production and consequently spent less time in coffee farming. Overall, farmers showed motivation in dealing with pest and disease problems. However, they were constrained by a lack of knowledge about the types of cultural control methods available and how they are applied. Agricultural extension and research workers must interact with coffee farmers on a regular basis. In doing so, effective communication is more likely to occur between farmers and extension officers. Regular contact will lead to better exchange of information regarding available cultural control methods. Also, farmers can be made aware of appropriate modern technologies that are locally available. These farming technologies can be used to enhance coffee production. This study shows that farmers' perceptions and understanding of coffee pests and diseases are low indicating a strong need for greater awareness of pest and disease management. With the limited knowledge on coffee pest and disease control, incursion of new pests such as coffee berry borer may be even worse and difficult to control.

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