A bridge too far? The influence of socio-cultural values on the adaptation responses of smallholders to a devastating pest outbreak in cocoa

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Abstract
The influence of socio-cultural factors on the adaptive capacity, resilience and trade-offs in decision-making of households and communities is receiving growing scholarly attention. In many partly transformed societies, where the market economy is not well developed, livelihood practices are heavily structured by kinship and indigenous social and economic values. Farm investment decisions and incentives to produce agricultural commodities are shaped by a host of considerations in addition to market imperatives like profit. In one such partly transformed society in East New Britain Province, Papua New Guinea, we examine the adaptation decisions of smallholders in response to the drastic drop of yield in their cocoa plots caused by the sudden outbreak of Cocoa Pod Borer. To explain why the impact of the pest has been so great we examine the interconnections between household responses, the local socio-cultural and economic context of smallholder commodity crop production and the wider institutional environment in which household choices and decisions are made. We argue that the significant lifestyle changes and labour intensive farming methods required for the effective control of Cocoa Pod Borer are incompatible with existing smallholder farming systems, values and livelihoods. To adopt a high input cropping system requires more than a technical fix and some training; it also requires abandoning a 'way of life' that provides status, identity and a moral order, and which is therefore highly resistant to change. The paper highlights the enduring influence and significance of local, culturally-specific beliefs and socio-economic values and their influence on how individuals and communities make adaptation decisions.

Keywords: Household decision making; adaptation; resilience; export cash cropping; livelihoods; cocoa smallholders; pest outbreaks

1. Introduction
There are approximately 570 million family farms worldwide, producing 80% of the world's food supply and relying mainly on family labour (FAO, 2014, p. 9). Most of these farms are very small with about 72% of them being less than 1 ha (FAO, 2014, p. 10). In the developing world many of these small farmers are engaged in export cash cropping of coffee, cocoa, oil palm and a range of other crops. The small size of their farms and limited resources, particularly access to labour, technology and financial capital, leaves them vulnerable to the effects of environmental perturbations

such as those associated with climate change. Cocoa farming, the subject of this paper, is particularly vulnerable to these risks and uncertainties given that 80-90% of cocoa worldwide is produced by small, family-owned farms (World Cocoa Foundation, 2014). While demand for cocoa is rising at 2-3% per year, the industry is confronted by a range of threats which impact directly on some of the world's poorest farmers. In the major growing regions of Africa, Asia and the Americas, 30-40% of the crop is lost to pests and diseases (World Cocoa Foundation, 2014). In Malaysia in the 1990s (Neilson, 2007) and Papua New Guinea (PNG) since 2007 (Curry et al., 2009), the devastating pest, Cocoa Pod Borer (*Conopomorpha cramerella*) (CPB), has decimated smallholder production and incomes.

This paper examines the adaptation decisions of smallholders in East New Britain Province (ENBP), PNG, in response to the drastic drop of yield in their cocoa plots caused by the sudden outbreak of CPB. The arrival of CPB was a major disruption to people's livelihoods because it presented to farmers an all or nothing scenario — one had to become a modern, high-input farmer and adopt a technically advanced cocoa cropping system to continue as a cocoa farmer because the traditional low-input cropping system meant virtually no healthy mature cocoa pods were available to harvest. We argue people had to transform themselves, individually and collectively, to remain in cocoa production. This involved adopting new values (more market orientated) and new agricultural practices that required much more investment of family labour time and money in the cocoa plot. These major lifestyle changes were often incompatible with a cultural infrastructure or 'way of life' comprising indigenous values, socio-economic practices and traditional farming methods. We argue that the socio-cultural tensions associated with adaptation decision-making, especially those decisions requiring a transformation of values, social relationships and lifestyles, need more consideration in the adaptation literature. Understanding these tensions is especially important for researchers examining adaptation in societies experiencing modernisation and the transition to a market economy.

As Lauer (2014, pp 1-2) explains, "[m]odernity increasingly presents novel circumstances fundamentally challenging the basis of sociality, the cultural logics that mediate self-interest and community well-being…". Modernity and tradition and their dichotomous characteristics and values like individual vs group, market relations vs indigenous economic relations, exclusive vs inclusive property rights and monoculture vs polyculture, mean there are often inherent tensions in partly transformed societies that may impede particular adaptation pathways, such as those requiring full marketisation of social relationships and the economy (Curry and Koczberski, 2013). This paper contributes to widening the discussion on the tensions and trade-offs that can arise in adaptation decision-making when societies are confronted with choices that have the potential to change their value systems and moral frameworks in quite fundamental ways.

Our study fits into a wide body of research across diverse farming communities that has shown farm household adaptation decision-making is not independent of the environmental, political and socio-economic contexts of farming including the cultural values and historical experiences that have shaped farming practices (e.g. Blaikie and Brookfield, 1987; Mortimore and Adams, 2001; Adger, 2003; Mortimore, 2003; Chowdhury and Turner, 2006; Osbahr et al., 2008; Nielsen and Reenberg, 2010; Oliver-Smith, 2013; Labeyrie et al., 2014; Kerr, 2014). It is for this reason

adaptation practices and adaptive capacity are highly variable socially, spatially and through time (Davies, 1996; Nielsen and Reenberg, 2010). Adaptation decisions are rarely made in response to one specific risk or a single event. Rather, a myriad of interacting factors and multiple stressors typically play a larger role in decision-making than the immediate risk itself (Smit and Skinner, 2002, p. 104; Quinn et al., 2011; Lauer, 2012). For example, pressure on household resources (particularly land and labour), will interact with indigenous knowledge, ecological factors, commodity prices, poverty, etc., to affect adaptation decision-making.

Similarly, long-standing research among farming households in the Sahel has also revealed that adaptive decisions, made as a consequence of a specific risk event, invariably fit within a larger set of adaptive practices, livelihoods and belief systems that have emerged or been modified over a long period. These practices are part of on-going risk management strategies enabling individuals and households to survive in particular environments (Ellis and Swift, 1988; Mortimore and Adams, 2001). Moreover, as Smit and Skinner (2002, p. 104) note, farmers' decisions to adopt or modify agricultural practices are usually made "not in a 'once-off' manner but in a dynamic on-going 'trial-by-error' process". All farming communities have innovators who will experiment and bear risks to find new ways of bringing together the factors of production, which, if suitable, are subsequently adopted by others in the community (Reij et al., 2009). Whilst some rapid adaptations in farming systems can occur during brief periods of abrupt change, most involve gradual and incremental change over time. Thus, longitudinal and historical analyses of adaptation practices in a community are valuable for understanding why particular strategies have been adopted by farmers in response to sudden shocks to their farming systems (Scoones, 2009).

Sometimes experimentation and selection require farmers to make trade-offs to manage or reduce the perceived level of risk and uncertainty (Carpenter et al., 2001; Whitehead, 2002; Osbahr et al., 2008; Lauer, 2014; Rigg and Oven, 2015). However, such trade-offs may not always enhance the resilience of households, and could be considered unsuccessful adaptations or maladaptive (Barnett and O'Neill, 2010; Goulden et al., 2013; Lauer, 2014). For example, stronger engagement in export cash cropping at the expense of subsistence food production may increase cash income and the capacity to purchase store foods during drought, but it also leaves households more vulnerable to the vagaries of fluctuating prices of commodity crops on international markets. The notion that adaptation decisions and certain trade-offs may not always be successful or desirable raises the concept of a household's resilience and the factors that affect adaptive capacity. Resilience is a function of adaptive capacity (Blakie et al., 1994; Oliver-Smith, 2013; Lauer, 2014). As Lauer (2014, p. 2) explains "resilience is achieved by maintaining certain adaptive capacities such as high levels of local ecological knowledge, flexible governance systems, and diverse livelihood strategies, combined with ecological factors such as high biodiversity, greater abundance of key species and complete community structure" (see also Berkes et al., 2003; Fabinyi et al., 2014).

The influence of socio-cultural factors on the adaptive capacity, resilience and trade-off decision-making of households and communities is receiving increasing attention in the literature (e.g. Robledo et al., 2004; Naess et al., 2005; Tompkins, 2005; Crane, 2010; Nielsen and Reenberg, 2010; Cote and Nightingale, 2012; Fabinyi et al., 2014).

In many societies, particularly where the market economy is not well developed, livelihood practices are heavily structured by social and kinship relationships and indigenous social and economic values. Land tenure arrangements, investment decisions and incentives to produce agricultural commodities are shaped by a host of considerations in addition to market imperatives like profit (e.g. Carrier and Carrier, 1989; Banks, 1999; Curry, 1999, 2003; Goddard, 2000; Imbun, 2000; Horan, 2002; Van der Grijp, 2004; Sahlins, 2005; McGregor, 2007; Minnegal and Dwyer, 2007; Cahn, 2008; Koczberski et al., 2009; Maclean, 2010; Thornton et al., 2010; Bainton, 2011; Curry and Koczberski, 2013; Curry et al., 2012a; Boyd, 2013; McCormack and Barclay, 2013; Mosko, 2013).

The influence of socio-cultural factors on adaptive capacity is illustrated by Nielsen and Reenberg (2010) who showed how cultural factors largely explained the very different adaptation strategies taken by two different ethnic groups in response to drought and climate variability in a village in northern Burkina Faso (for another interesting case study, see Nykvist and von Heland, 2014). While one group, the *Rimaiibe*, diversified their livelihoods successfully, the other group, the *Fulbe*, were reluctant to do so for cultural reasons. Their "adherence to the traditional concepts of *ndimaaku* (personal integrity; worthiness), *semteede* (shame) and *pulaaki* (Fulbe-ness) … challenged livelihood diversification options … in substantial ways." (Nielsen and Reenberg, 2010, p. 151). The *Fulbe*, unlike their neighbours and former slaves the *Rimaiibe*, were challenged by livelihood diversification that was seen to undermine their way of life and place them at the same social level as their social inferiors, the *Rimaiibe*. Thus, adaptation represented an existential challenge for the *Fulbe*, and they were reluctant to cross that threshold.

Crane (2010, p. 19) who defines cultural resilience "as the ability to maintain livelihoods that satisfy both material and moral (normative) needs in the face of major stresses and shocks…" asks what happens when that threshold is crossed. He poses the question:

> Is it possible for the ecological and material components of a system to be resilient, while at the same time a cultural group within it is pushed over a threshold to a new state in which the most valued practices and beliefs become untenable, irrevocably transforming the culture itself? (Crane, 2010, p. 2)

Disruptions caused by stresses and shocks are periods marked by tension or conflict in which new cultural practices and values can emerge, and which, as Crane (2010) maintains, make it difficult to revert to original cultural practices and values. Drawing on Crane's concept of cultural resilience, we argue that most cocoa farmers were not pushed over the threshold to adopt the new practices and values associated with the high-input cropping system. Although they were left worse off financially, they retained much of their 'way of life' by scaling back their engagement with the cash economy and putting more emphasis on subsistence production.

2. Study area and methods

2.1. CPB and cocoa history

In March 2006 CPB was first detected on the Gazelle Peninsula, ENBP, PNG (Figure 1). Two eradication programmes were attempted with rampasan (removal of all pods longer than 6-7 cm) and heavy pruning with follow-up 'mop-up' operations until September 2007 (for information about CPB control, see Mumford and Ho, 1988) (Figure 2). By June 2008 there were six confirmed CPB outbreaks outside the eradication zone (Curry et al., 2009). The impact on cocoa yields and incomes was sudden and dramatic: of a sample of 152 family cocoa holdings in 2008, there was over 90% loss of crop with an average of less than one healthy ripe cocoa pod per tree available for harvesting (Curry et al., 2009, p. 21). Since 2008, CPB has continued to spread and by 2012, cocoa production had fallen to just under 4000 tonnes, an 80% decline in total production for the province. CPB has also spread to PNG's other main cocoa growing provinces of Autonomous Region of Bougainville and East Sepik Province (Figure 3).

Figure 1. Location of East New Britain Province.

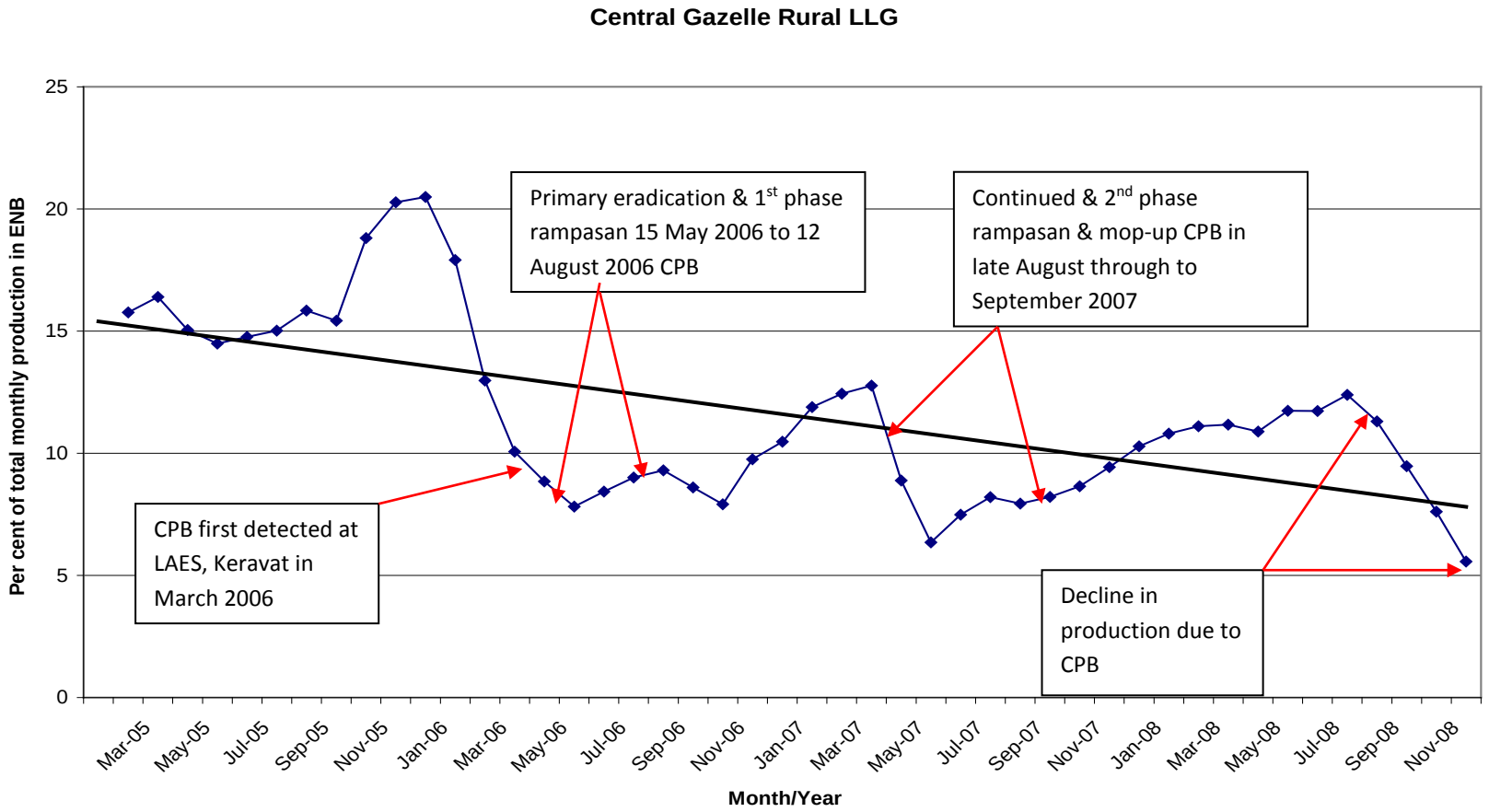

Figure 2. Total monthly production of cocoa dry bean for Central Gazelle Rural Local level Government (LLG) expressed as a percentage of total production for ENBP (Source: PNG Cocoa Board).

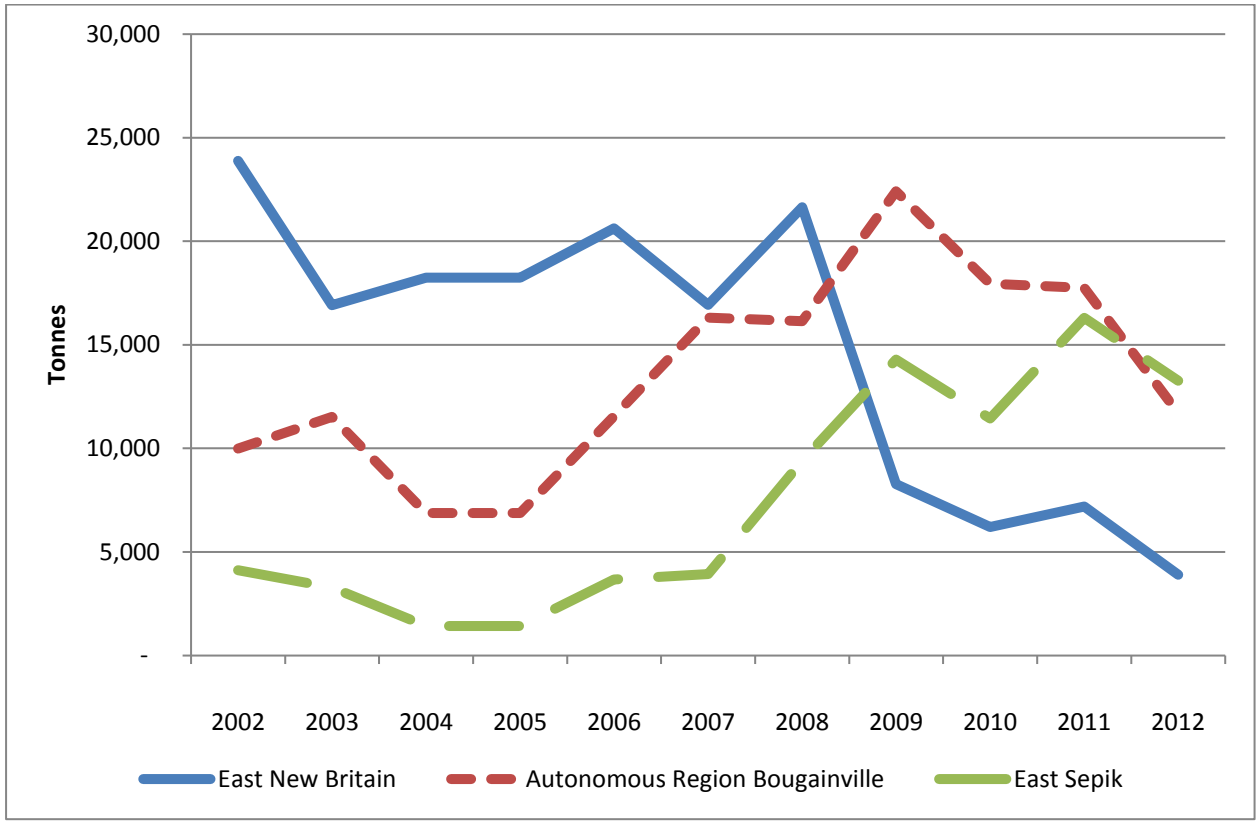

Figure 3. Cocoa production for PNG's three main cocoa growing provinces. (Source: PNG Cocoa Board)

Prior to the arrival of CPB, the Gazelle Peninsula was the major cocoa growing area in ENBP and in PNG (Figure 1). Plantings of cocoa by family farmers on their customary land began after World War II and spread rapidly in the 1950s with Australian administration financial and technical support (Epstein, 1969). The provincial economy was heavily reliant on cocoa production. Cocoa constituted almost half the value of the province's exports and was the primary income source of approximately 73% of the rural population (Curry et al., 2009). In addition to smallholder production, many people were employed in processing, marketing and the transport of cocoa, and the main national government-funded research and extension organisations in cocoa were located in ENBP. In all, a substantial proportion of employment in ENBP was directly or indirectly related to the cocoa industry. The Gazelle Peninsula like other rural areas of PNG has few cash-earning opportunities outside agriculture.

2.2. Data collection

This paper draws on data collected during three phases of fieldwork in ENBP: 2003-2005 – before the arrival of CPB; 2008 – soon after the CPB incursion and spread; and 2009-2011 – several years after CPB became established. Both quantitative and qualitative methods were employed. The household was the unit of analysis with attention paid to the range of economic and social activities that household members pursued in addition to cocoa production. External factors, such as the role of extension, market access, cocoa prices and marketing were also examined.

2.2.1. First phase of fieldwork: 2003-2005

In the first phase of fieldwork, data were collected from two LLG areas in the northeast of the Gazelle Peninsula: Malakuna No. 4, Ulautava and Tinganavudu villages in the Kokopo-Vunamami LLG area; and Vunalaiting Village in the Livuan-Reimber LLG area. Data collection was in three parts: repeat interviews with 14 households on a weekly basis, a socio-economic survey of 93 households and an assessment of cocoa farm management standards on 98 cocoa plots (for further details see Curry et al., 2007)

The weekly interviews were undertaken over a four-week period in both October-November, 2003 and May 2004 with a final round of interviews among Vunalaiting Council Ward villages over a five-week period in December 2004 and January 2005. Each week a standardised survey instrument was administered. This recorded information for the previous seven days, including: quantity of cocoa sold; income earned from cocoa and other livelihoods; household and extended family labour contributions to cocoa production; and household contributions to communal and village customary activities. These surveys explored the role and place of cocoa in farming systems and household livelihoods.

The household socio-economic survey was conducted in late 2003 in the same villages selected for the weekly surveys. The survey collected information on: household demographics; cocoa plots; pods harvested and beans sold in preceding seven days; and farm and non-farm income sources; farmer training and extension received; and ownership of farm tools. In November and December, 2004, a farm management assessment survey was conducted on 98 smallholder cocoa plots belonging to randomly selected cocoa farmers in the Livuan-Reimbar LLG. For each cocoa plot, the survey recorded pest and disease levels, plot maintenance standards (weeding, pruning and shade control) and included a pod count of healthy and pest and disease affected pods.

2.2.2. Second phase of research: 2008
The second phase of fieldwork in November 2008 examined the impact of CBP on household livelihood strategies and on the economy of ENBP. Interviews were conducted with 152 smallholder growers and their families in three wards in two LLGs: Kareeba/Vudal in Inland Baining LLG and Tavilo in Central Gazelle LLG. All three wards were on the Gazelle Peninsula and CPB was well established in each. Household interviews explored the impact of CPB on harvesting, processing, cocoa plot management and livelihood strategies. In parallel with the household interviews, a farm management assessment survey was carried out of each household's nearest cocoa plot. The design was based on the 2004 assessment survey described above. To assess the impacts of the fall in cocoa incomes on the broader local economy interviews were also held with village and town business owners and operators, school teachers and principals, police and government and private sector stakeholders in the cocoa industry (for further information see Curry et al., 2009).

2.2.3. Third phase of research: 2009-2011
The main emphasis of the third phase of data collection was on how cocoa farmers were responding and adapting their livelihoods to the presence of CPB and to assess the effectiveness of extension training offered to smallholders to control CPB. Data were largely collected from farmers in the same wards as the 2008 surveys, and where possible from the same villages the research team had worked in prior to CPB. Additional data were collected in villages on the Gazelle Peninsula where farmer groups had developed partnerships with the private sector. Both qualitative and quantitative data were collected and various methodologies were employed including farm management assessment surveys (described above); farmer activity diaries (Apis et al., 2013); informal interviews with smallholder households and extension providers; and general observations and informal interviews while attending community and farmer group meetings.

Farm management assessment surveys were conducted on cocoa plots belonging to 132 households in four villages: Tavilo, Tabaule, Tinganagalip and Vudal/ Kareeba. Farmer activity diaries were undertaken over a 14 day period in two of the villages: 32 farmers in Tavilo and 34 farmers in Tinganagalip. The activity diaries recorded the farm and non-farm labour activities of each household member and were designed to assist in quantifying how farmers were responding to CPB and the uptake of CPB training. Informal interviews were held with those farmers participating in the activity diaries and the management assessment surveys. Over 30 farmer group meetings were attended in four villages during 2009-2011. Several interviews were recorded with trainers in the commercial and government sector providing CPB training to farmers.

3. Results

3.1 The role and place of cocoa in farming systems and household livelihoods
While cocoa was by far the dominant source of household cash income prior to the CPB incursion, farmers spent very little time in their cocoa plots and pursued a range of livelihoods in addition to cocoa (Omuru et al., 2001; Curry et al., 2007; Nelson et al., 2011). Only during the main cocoa flush periods, or when cocoa prices were exceptionally high and people thought returns to labour were sufficiently good to forego other socio-economic activities, would they increase their labour inputs in cocoa. Smallholders harvested cocoa to meet immediate cash needs (e.g. small purchases of soap, kerosene, rice and tinned fish) and occasionally engaged in more intensive harvesting to meet large expenses like school fees, indigenous exchange obligations like brideprices and mortuary payments or church fund-

raising events. Thus, prior to CPB, the low input cocoa cropping system required relatively little labour and provided a good return to labour but a poor return to land due to low yields.

Approximately seven or eight years after being planted and without pruning and shade control the cocoa plot passes prematurely into a low productivity 'foraging' phase (Curry et al., 2007). The premature 'ageing' of the cocoa plot further reduces the motivation of smallholders to commit labour to plot maintenance, and the cocoa plot becomes like any other 'bush' resource or old abandoned food garden reverting to fallow, where it is visited, largely by women, to 'forage' for small quantities of ripe pods to sell as unprocessed wet bean.

Households devoted much time to food crop production in the typical Melanesian system of swidden cultivation. Garden crops are dominated by bananas (*Musa spp*), sweet potato (*Ipomoea batatas*), Chinese taro (*Xanthosoma sagittifolium*), cassava, sugar cane (*Saccharaum spp*), pitpit (*Saccharum edule*), corn, pumpkin and a variety of leafy vegetables and other minor crops. Cocoa plots are not monocultures of cocoa; they are often interplanted with other perennial crops such as fruit trees, bananas and coconut palms (as a shade crop for cocoa) and with patches of annual crops where cocoa trees have died. Most households sold garden food crops at local markets as well as a range of fruits, nuts and dry coconuts. Such strategies diversified incomes and also distributed income throughout the year. Other livelihoods pursued by cocoa farmers included the production and sale of copra, and managing small village enterprises such as poultry production and village tradestores.

Cocoa farmers, like most rural Papua New Guineans and Melanesians more broadly, also attach much importance to activities that are not directly related to earning cash income, but which depend on cash and are central to maintaining social and kinship networks and community cohesiveness (Curry and Koczberski, 2012; Curry et al., 2012a). Like elsewhere in PNG, indigenous exchange is central to social and cultural life and the capacity to engage in exchange is a key determinant of life quality. For example, villagers devote much time, labour and cash to church, community, traditional activities and socialising (visiting friends and relatives). Thus, cocoa smallholders engage in a diverse range of livelihood and social activities that are important for maintaining the economic and social well-being of families, extended kinship groups and village communities.

In summary, prior to the CPB incursion, cocoa was the main source of cash income for households, and the low input, low yield cropping system did not require a large investment of family labour. This low input cropping system allowed family labour to be deployed in a range of activities including food production and also allowed time for household members to engage in a wider range of socio-cultural activities typical of Melanesian social life.

3.2. Livelihood responses to CPB

With their cocoa trees heavily infested with CPB and little or no crop to be harvested, the initial response by most farmers was to either abandon or partially abandon cocoa production. It has long been known that cocoa growers in this area, prior to CPB, tolerated high rates of crop losses from pests and diseases and few practised pest and disease control measures (Ghodake et al., 1995; Konam, 1999; Omuru et al., 2001; Drenth and Sendall, 2004; Curry et al., 2007). In a sample of 100 farmers on the Gazelle peninsula, 82% and 73% of farmers identified cocoa pests and diseases respectively as the most important factors limiting cocoa production (Omuru et al., 2001). Prior to CPB, Curry et al., (2007) reported that one-third of mature pods in smallholder cocoa plots on the Gazelle Peninsula were lost to pests and

diseases, mainly Black Pod and Pod Rot. Thus, although pest and disease losses had been significant prior to CPB, smallholders had never experienced the near total loss of crop as experienced with CPB (Plate 1).

Plate 1. CPB-affected pods.

With a dramatic loss of cocoa income, smallholders adopted an array of livelihood options which have varied in importance since 2007 when the impact of CPB began to be felt. An immediate response was a sharp reduction in cash outlays. Consumption of store foods fell markedly with almost half (48%) of families reporting that they rarely purchased store foods. Expenditure on health and education also decreased with 87% of families reported cutting back on medical services in the initial infestation period (Curry et al., 2012b p. 166), and 81% of families with school age children said they were having difficulties paying school fees.

Families also reduced the amount of financial support given to the extended family to meet social and cultural obligations. In November 2008, only 17% of families were still striving to meet these obligations while 61% claimed to have stopped supporting relatives outside the immediate family. The loss of cash income, therefore, not only reduced material aspects of life quality, but also the quality of life associated with indigenous cultural values and practices.

3.3. Restructuring livelihoods

As CBP persisted, smallholders began modifying their livelihood strategies. This involved scaling-up some existing livelihood activities, establishing new ones, and/or cutting back livelihood activities that became unviable. Livelihood activities that were curtailed included village tradestores and small transport businesses that depended on patronage from the village community. Many village stores closed and remaining ones struggled to remain viable (Curry et al., 2012b).

The primary strategy pursued by farmers was to scale-up garden food production, both for household consumption and sale at local markets. Food gardening was the preferred initial response because it was an activity people were familiar with, and marketing of fresh food has long been an important livelihood strategy for rural households in ENBP. Following the arrival of CPB, sales of garden foods at local markets became the major source of income for

most cocoa-growing households. Sixty per cent of men and 84% of women ranked income from local marketing of garden crops as their primary source of cash income. Smallholders claimed they expanded plantings of high-value crops, such as sweet potato (*Ipomoea batatas*), Chinese taro (*Xanthosoma sagittifolium*), pawpaw (*Carica papaya*), peanuts (*Arachis hypogaea*) and a variety of leafy green vegetables. Although, income from local markets became the top ranked income source for both men and women, household income remained low and uncertain, and lower than had been earned previously from cocoa in the pre-CPB environment.

3.4. Returning to cocoa

As farmers began to recognise that CPB was an enduring problem, increasing numbers of them attempted to adapt to the new production environment by attending training programmes to manage CPB. By 2008, approximately 60% of surveyed farmers attended training provided by the private and government sectors (Curry et al., 2009). The relatively high rates of attendance suggested a willingness of farmers to modify their field practices for a CPB environment. The training emphasised improved plot sanitation and CPB control techniques. It showed farmers the key elements of a labour-intensive CPB management regime that required weekly harvesting of all mature cocoa pods, removal and burial of all diseased and CPB-affected pods (Plate 2), regular pruning and shade control, weed control and insecticide spraying.

Plate 2. Uncovered pit containing CPB infested pods and the skins of harvested pods.

This new high-input cropping system to control CPB represented a large increase in farming inputs from the pre-CPB era. Only a small proportion of farmers successfully adopted the new labour-intensive strategies to control CPB. When attempts were made to implement the new CPB control techniques it became apparent that plot management was not of a sufficiently high standard for effective control of CPB (Figure 4), though there was a slight improvement in standards on pre-CPB times (Figure 5). Thus, cocoa yields remained very low and most farmers continued to rely heavily on production of food crops for local markets.

The next section examines why so many households have not returned to cocoa. We identify three interrelated factors constraining people's capacity to control CPB: 1) smallholders' limited access to quality extension training and support programs to control CPB; 2) the high labour demands required to implement the field management practices necessary to control CPB; and 3) a reluctance to adopt 'modern' farming methods. Each is discussed below.

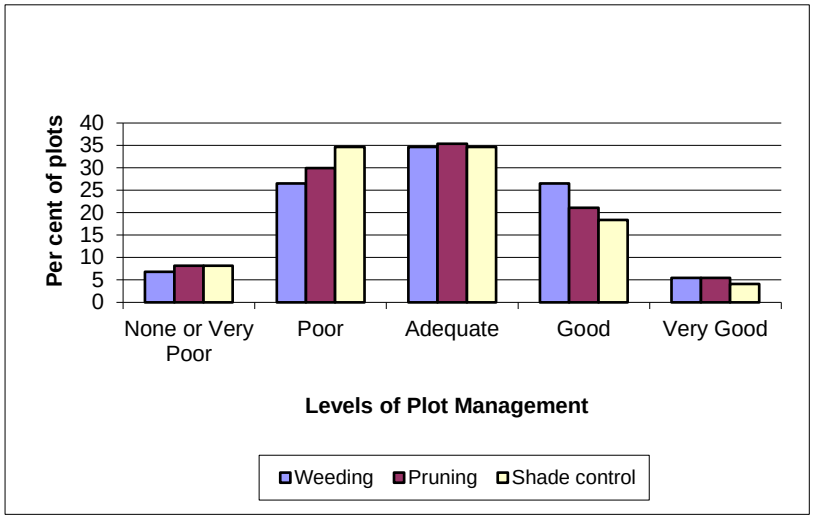

Figure 4. Weeding, pruning and shade control levels in November 2008 for the three study sites combined (n=147)*

*The same scale was used in the pre-CPB period in 2004-5 to assess plot maintenance levels. For effective control of CPB, management standards would need to be 'Good' or 'Very good'.

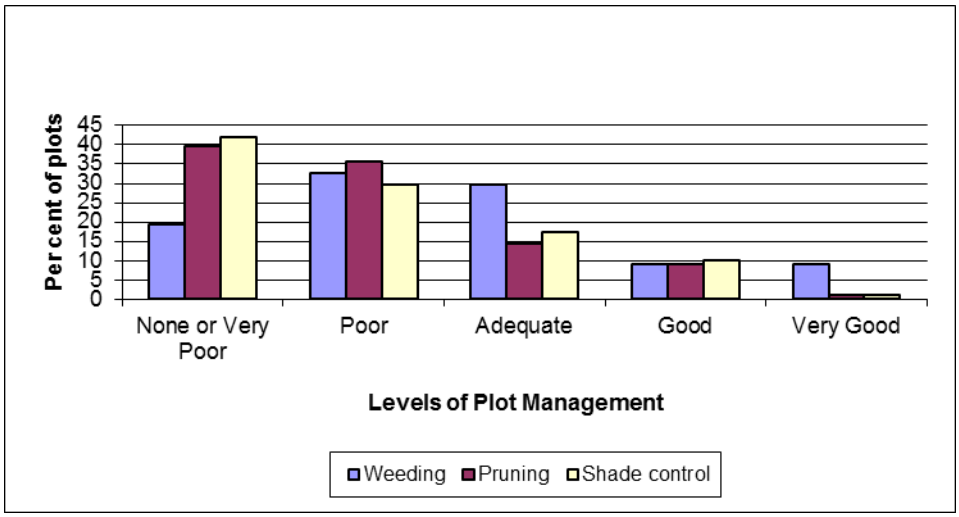

Figure 5. Weeding, pruning and shade control levels in at Tabaule and Vunalaiting villages in December 2004/January 2005 (n=98) (Source: Curry et al., 2007, p. 73)

3.4.1. Limited access to quality extension training and support programmes

The impact of CPB and the difficulties farmers have faced in adapting their cocoa cropping systems have been exacerbated by the limited availability of quality training and support programmes, both in the public and private sectors. When CPB was first detected in ENBP, the province had six government cocoa extension officers: an extension officer to grower ratio of 1:3833. The provincial Department of Primary Industry (DPI) had allocated their own extension officers to train farmers on CPB management, although the capacity and resources of the government extension services remained inadequate to maintain the necessary levels of extension programmes to ensure sufficient numbers of farmers received training and follow-up support.

Despite the national government's allocation of some funds to the main government institutions responsible for cocoa, especially CCIL, PNG Cocoa Board and the ENB provincial DAL, funding has been inadequate and piecemeal. This has hindered the implementation of a long-term, well-coordinated government-led CPB programme for the province, though in 2010 the World Bank funded a programme of cocoa rehabilitation and training. A national strategic plan for CPB has yet to be developed. Thus, a lack of funding and governance issues have undermined the ability of government institutions to equip smallholders with the necessary training, information and other resources to develop their capacity to control CPB.

The small proportion of farmers who have successfully adapted their cropping systems to manage CPB were members of farmer or cooperative groups which had the financial resources to invest in their farms or were linked to comprehensive training and support programs. The latter is important as it often includes access to subsidised tools, seedling supply and credit. To implement CPB management techniques, farmers were encouraged to reduce the area of cocoa from an average of 2.5 ha per household to around 1 ha per household, and to replace old and tall cocoa trees with new hybrid clones that were smaller, easier to manage and higher yielding than their old cocoa trees. Also, with access to tools to rehabilitate and maintain their cocoa holdings, labour efficiency was much greater. However, those farmers not linked to support programmes and whose cocoa incomes had been decimated could not afford to purchase seedlings nor tools. Typically, tool ownership rates were low among cocoa farmers in ENBP, and prior to CPB, one quarter of cocoa stands were more than 21 years old (Kakul, 2006). Cocoa plots had never been rehabilitated nor managed for high production with appropriate shade control and pruning standards. Thus, access not only to training, but to other support services was necessary for farmers to make the transition to high input cropping. Insufficient government support together with a private sector too small to plug the gap in government services have constrained smallholders' capacity to develop the skills to make the long-term changes necessary for reinvigorating cocoa production.

3.4.2. The high labour demands to control CPB

An important factor explaining why so many farmers have not returned to cocoa farming concerns the increased labour inputs required to control CPB. While tools that increase labour efficiency have helped address this problem, they are not enough on their own. To understand why meeting the high labour demands for CPB management presents such a challenge for smallholders, consideration must be given to the smallholder farming and livelihood system in place when CPB arrived. Prior to CPB, cocoa farming was based on very low levels of farm inputs, particularly labour. This low-input, low-output cropping system, which we labelled the 'foraging production strategy' (Curry et al., 2007), meant very

little or no labour was allocated to plot maintenance. The characteristics of this low input system of production amongst cocoa growers have been noted consistently in studies of smallholder farming in ENBP since the 1980s when such studies began (e.g. Nicholls, 1989; Yarbro and Noble, 1989; Ghodake et al., 1995; Omuru et al., 2001; Curry et al., 2007).

Generally, labour inputs are higher in new cocoa plots when cocoa trees are young and they are intercropped with food crops. For the first few years after planting cocoa, farm families tend to visit their plots frequently to weed food crops and undertake some formation pruning of cocoa trees. Shade control is also more likely to be performed in this early stage to promote food crop growth rather than cocoa production. At the immature cocoa stage, the maintenance of intercropped food crops ensures almost total weed control in young cocoa plots. However, as the cocoa trees become larger and more established, and as food gardening declines with increasing shade levels, labour inputs for pruning, shade management, and pest and disease control begin to decline to very low levels (Figure 5) (Ghodake et al., 1995, Curry et al., 2007).

The foraging production strategy practised by farmers since cocoa was first introduced was modelled on the low-input production and labour strategy underpinning management of food gardens in the early fallow stage. In this swidden system, food gardens were cultivated intensively for two to three years with labour mobilised from the extended family for large tasks like the clearing and firing of the bush. Labour input declined with the age of the garden. At the end of the gardening cycle, pitpit (*Saccharum edule*) cuttings were planted in a mature banana stand which marked the end of the planting cycle and the garden reverted to fallow. The garden continued to produce foods such as pitpit and bananas for several more years, until the fallow vegetation eventually took over with trees coming to dominate the fallow. With the planting of pitpit there was little further maintenance of the garden. Like old and overgrown cocoa plots, visits to these older food gardens were infrequent, and the brief visits were largely undertaken by women to harvest pitpit or bananas for household consumption. By this less productive stage, men have redirected their labour to their younger, more productive food gardens. Similarly, in cocoa, as yields decline as the cocoa stand ages, smallholders begin to divert their labour elsewhere, including, if land is available, planting a new cocoa stand often in a newly cleared garden site (Curry et al., 2007). In the latter case, little additional labour is required to establish a cocoa plot on a newly cleared garden site compared with the amount of labour required to rehabilitate an old cocoa stand. This is why the area of cocoa holdings is positively correlated with the age of male farmers (Curry et al., 2007).

A central factor explaining the adoption of the foraging production strategy in cocoa was the limited availability of household labour for cocoa production. Most smallholder households rely on unpaid family labour for both subsistence and cash crop production, and despite the large size of families, functional rather than absolute labour shortages have long been recognised as a constraint on smallholder productivity (see Ghodake et al., 1995; Lummani and Nailina, 2001; Omuru and Fleming, 2001; Curry et al., 2007; Nelson et al., 2011). Household labour constraints result from a range of interacting factors, including demographic characteristics of the household, reluctance of some family members to commit labour to cocoa production, a reluctance to recruit hired labour, and, importantly, competing economic and non-economic demands on household labour and time. These labour issues largely reflect the livelihood and socio-cultural priorities of smallholder households and have developed within the context of a wide set of competing demands for labour that are central to maintaining social and kinship networks and diverse livelihoods.

In the pre-CPB environment, the low labour input strategy for cocoa production was sufficient to maintain reasonable yields (though well below potential levels), in terms of returns to labour, despite high levels of losses due to pests and diseases in overgrown and over-shaded plots. For most smallholders this cocoa farming system functioned well in meeting their cash and household needs and was able to be accommodated within a broader suite of livelihood strategies and socio-cultural practices that were based on labour flexibility across a range of activities. However, such low-input management methods were ineffective for controlling CPB, and with the sudden arrival of CPB, existing cocoa farm management practices were rendered obsolete. Indeed, the low-input farming system has, to an extent, increased farmers' vulnerability to the impacts of CPB because of the need for a sharp increase in labour inputs to remain viable.

3.4.3. Farmers' reluctance to adopt modern farming methods

A closely related factor explaining why most farmers have not returned to cocoa is that many are not prepared to adopt modern farming methods. Cocoa farming in a CPB environment requires more than a large increase in labour inputs; it also requires financial investments in tools, insecticides and other inputs. These alone require major changes in people's activity regimes and their cocoa and non-cocoa investment strategies. Most difficult for smallholders to adopt is the radical change in lifestyle and the suspension of indigenous economic and social values that underpin labour, production and social relationships. For example, the adoption of a savings culture to finance on-going farm inputs is difficult in a society where much cocoa income is dissipated through social and kinship networks to meet socio-cultural obligations. Whilst this indigenous exchange economy can at times motivate smallholders to commit extra time and labour to cocoa production, and thus increase total production, the additional income does not always lead to increased savings (Curry et al., 2007; Curry and Koczberski, 2013). Retaining recurrent income from cocoa for reinvestment in farm inputs is, therefore, a major challenge. For this reason many of the farmers who have successfully made the shift to CPB farm management techniques were linked to credit facilities, arranged for exporters/processors to make automatic savings deductions from their payments, or received subsidies to assist with the purchase of tools and seedlings.

As noted above, prior to CPB, whilst cocoa was the main income source within this livelihood system, it did not dominate people's lives in terms of labour inputs and time allocation (Curry et al., 2007). Food gardening and activities that maintained and strengthened the indigenous economy and community were typically allocated more time than cocoa production (Curry et al., 2007). Other income-generating activities, household domestic tasks and leisure were also important. Such non-cocoa activities predominantly determined the amount of time and labour household members were prepared to allocate to cocoa (for further discussion see Curry et al., 2007). In this system, labour was highly flexible and provided mainly by family members and extended family through reciprocal labour exchange arrangements.

The social value of labour within this system that relied on family labour and traditional reciprocal labour exchange arrangements was very important. In pre-CPB times, labour contributions to subsistence food production, cultural and religious events and to cocoa production were structured by kinship and social relationships. They were often on a reciprocal basis where smallholders, and members of their respective families, would assist each other with larger tasks like clearing new garden sites, preparing for feasts and harvesting cocoa. In the case of cocoa, after the work was done, the grower's family would join with

those who provided labour to share a feast of prestigious foods prepared by the grower's family. These exchanges were not about the payment of wages in a labour market; nor were they aimed singularly at generating profits; rather they were the bedrock of identities, upon which social and kinship relationships amongst individuals and groups were established, affirmed and expanded (Curry, 2007; Curry and Koczberski, 2009, 2012, 2013).

Thus, the social value of labour in cocoa production, like in other arenas of life, was very important, and it was not solely the market value of the labour deployed nor the value of the product of that labour that determined labour value in pre-CPB times. The social value of labour given or received was specific to the individuals involved and the groups with which they were affiliated. These meanings attached to labour in cocoa were similar to the meanings of labour reported from a range of different contexts in PNG and the South Pacific, more generally (see Modjeska, 1982, pp 51-65; Strathern, 1982; Strathern, 1990; Fajans, 1993; Kuehling, 2005; Sillitoe, 2006; Koczberski, 2007).

With the adoption of high-input farming of cocoa in a CPB environment, opportunities to realise the social value of labour have become much more constrained. This is because people must spend more time working in their own cocoa plots and less time pursuing other livelihood and social activities. The few farmers who have successfully made the transition to high input farming and practise CPB management strategies have intensified their labour inputs in cocoa production. Farmers, in addition to significantly increasing their own labour inputs in cocoa, are recruiting more hired labour for harvesting and other on-going maintenance tasks. Such labour is drawn from under-employed youth in the community and migrant 'outsiders' still resident in the area. Thus, for these households labour recruitment has become more market-based and more removed from indigenous labour exchange practices in which production was traditionally embedded.

For cocoa growers, the transition to high input farming requires them not only to learn new cocoa management skills and invest more in their farm but also to undergo an ontological transformation as they adopt different value systems that are more individualistic and market-orientated. To adopt a high input cropping system means abandoning some of the key markers of social identity and status tied to reciprocal labour arrangements and indigenous exchange more broadly. It means relinquishing opportunities to invest recurrent income in indigenous exchange as more income is reinvested in the cocoa plot. Also, with much more time devoted to cocoa production than previously, smallholders must curtail their pursuit of a range of social, cultural and church activities that the low-input system of production of pre-CPB days permitted and which were so central to their social lives. So, to adopt the recommended high input cropping system requires not only implementing new technical solutions involving the reorganisation of labour and increased inputs of labour and financial capital, but also a social repositioning in what is a strongly traditional Melanesian society still in transition to a market economy.

The results build on the work of Nielsen and Reenberg (2010) and Crane (2010), amongst others, who argued that cultural factors affect the adaptive capacity of individuals and communities in responding to environmental stress. As Nielsen and Reenberg (2010) showed for the transhumance *Fulbe*, livelihood diversification was a bridge too far because it meant adopting some of the characteristics of their former slaves thereby, in their view, changing the moral order.

Crane's (2010) study of the responses to drought by the *Marka* and *Fulani* of Madiama in the Sahel, two culturally and linguistically different groups living in proximity to each other, found that both groups adopted a more diversified livelihood strategy. However, the *Marka* cultural group was able to diversify their livelihoods while keeping their social institutions and identity markers relatively intact indicating a high degree of cultural resilience (p. 9). The *Fulani*, on the other hand, while compelled to move along the same path of livelihood diversification were less culturally resilient (pp 9-10). The *Fulani*, who had a long tradition of transhumant cattle herding, experienced cultural loss in the process of livelihood diversification. As Crane observed:

> [a]s the physical act of transhumance has become increasingly untenable … the social institutions and practices around transhumance are likewise diminishing, leaving the cultural valuation of herding unfulfilled. Even though agriculture is important in satisfying the material need of food security, it does not satisfy a cultural "need" and is [the loss of herding] experienced and socially constructed as a cultural degradation (Crane, 2010, p. 10)

In the present study, only a small proportion of farmers had made the transition to the high-input cropping system. Like the findings of Nielsen and Reenberg (2010) and Crane (2010), cocoa growers were also faced with adaptation decisions that went to the heart of their livelihood and cultural value system. For many, the decision to adopt modern cocoa farming methods and engage more strongly with the market economy was seen to conflict with traditional socio-cultural values and practices. This was expressed in the comments of some growers who said they would revert to a low input system of cocoa production if CPB were to disappear or become a minor problem. The dilemma for cocoa growers was that the indigenous socio-economy provided the arena where status was achieved, renown gained and where identities were created and affirmed. It was in this arena, not in modern farming practices, that culturally valued behavioural practices and moral values were displayed and performed. For external observers looking on, a perceived failure to adapt is an assessment out of cultural context which can lead to a superficial attribution of maladaptation to a lack of resources or skills.

4. Conclusion

When the cocoa crop was decimated by CPB, smallholders' initial response was to abandon cocoa production and immediately expand production of food crops for household consumption and sale at local markets. While this cautious response created a degree of livelihood stability, it was also indicative of how few alternative off-farm and non-agricultural income opportunities were available to cocoa households. This was in contrast to the situation in some parts of Southeast Asia where rapid industrialisation and labour migration have created attractive off-farm employment opportunities (e.g. Rigg, 2007; Thompson, 2007). However, despite increased production of food crops for local markets, income levels remained much lower than in pre-CPB times. Farmers had little choice but to reduce their levels of cash expenditure and move more firmly into a subsistence-like economy depending heavily on subsistence food production and other bush and marine resources for their survival.

Whilst the technical knowledge for managing CPB was well understood by industry leaders and extension providers, and growers themselves were aware that inputs, particularly of labour, must be increased significantly to control CPB, very few adopted the high-input

cropping system. As this paper has argued, the barriers to adoption were not simply technical, and nor were they because growers lacked the knowledge to control CPB (though these were undoubtedly factors). Rather, the adoption of high-input farming represented a major disjuncture in their way of life and in the values and practices that were so important in society.

This case study of cocoa producers in ENBP reveals the enduring influence and significance of local, culturally-specific beliefs and socio-economic values and their influence on how individuals and communities make adaptation decisions. Like for farming communities elsewhere in PNG and in many parts of the developing world, cultural beliefs and practices form a robust cultural infrastructure with its own rules and values that regulate the moral behaviour of its members and also provide measures of status and identity that are valued by the society. This cultural infrastructure which was resistant to change, was able in the pre-CPB environment to accommodate a low-input cocoa cropping system and a degree of engagement in the market without undermining accepted codes of behaviour and values imbued in indigenous socio-economic practices. However, in a CPB environment where the adoption of a high-input cropping system was required to remain in cocoa production, the cultural infrastructure and associated values and practices had to be neglected to accommodate these new farming practices. Without high levels of extension support this proved an insurmountable barrier for most farmers, at least to the present time. For external observers the inability or reluctance to adopt high-input farming can appear maladaptive in the sense that farmers are now worse off financially. However, as highlighted by this case study, maladaptation is in the eye of the beholder: when viewed in its cultural context, a degree of resilience is evident as farm families are able to respond to the CPB incursion by not adopting the high-input cropping system thereby preserving some aspects of their life worlds and practices that they hold dear.

Finally, that some cocoa farmers have successfully made the transition to high-input farming reflects a broader awareness among the community that these are difficult times requiring hard decisions in which sacrifices must be made. It is not the lure of modernity and the adoption of modern values that have driven this transformation of work, livelihoods and, possibly, values too. Rather, because cocoa production in a CPB environment is an all or nothing venture – there are no half measures – one either adopts high input farming or opts out. Many farmers who have successfully adopted the high input cropping system maintain that they would revert to the low-input foraging production strategy if CPB were to disappear. Lasting change may not happen with the present generation, but may later be adopted by a younger generation growing up in a CPB environment and for whom the old values and a way of life are giving way to individualism and a stronger commitment to market-driven production and its associated values.

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