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# Emergence of social groups after a biosecurity incursion

Aditi Mankad<sup>1</sup> · Matt Curnock<sup>2</sup>

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## Abstract

This paper examines the formation of social groups in the first 3 months following a significant biosecurity incursion, extending our understanding of a social system in the context of an ongoing emergency response. The broader implications of social change and coping responses post-incursion are a relevant and useful discussion worldwide. Farmers ( $N = 25$ ) were recruited from three dominant banana-growing regions in North Queensland, Australia. Face-to-face interviews were conducted using a semi-structured format. Key topics covered included perceptions of Panama Tropical Race 4 (TR4), on-farm biosecurity activities, social influences and comparisons, and personal stress. This qualitative approach uses well-known social psychological constructs to help understand and frame farmers' social behaviours post-incursion. TR4 was perceived as a significant threat by participants; yet, perceptions of vulnerability to TR4 and biosecurity engagement varied. Two dominant social groupings emerged from the data. *Active adopters* were characterised as proactive and innovative growers, prioritising individual farm protection for the benefit of the broader industry. There was a high level of social support, trust and efficacy, facilitating an adaptive coping style. *Passive adopters* implemented straightforward and less costly biosecurity measures on farm but were not willing to commit to greater financial or time investments. They expressed an overall wariness towards the biosecurity management process and little trust in authorities. A small sub-group of passive adopters also displayed clear maladaptive coping characteristics (e.g. denial, helplessness) towards TR4, believing that biosecurity action at this point was futile. Proximity to TR4-affected property emerged as having an interactional effect on biosecurity uptake and risk perception. Here, we show for the first time, in situ, the complex social environment post-incursion, indicative of high stress and high uncertainty. Findings can be used on-ground to improve extension engagement and risk communication with growers post-incursion, being mindful there exists a range of coping styles and social influences.

**Keywords** Identity · Panama disease · Social psychology · Social science · Farmers

## 1 Introduction

The way in which people cope with an environmental disaster is significantly variable and often depends on a psychological appraisal of the event, its perceived outcomes and one's role within the disaster context. Importantly, interactions between different groups of people, or indeed between different people

within a group, can influence individual interpretations of an event. This can facilitate or hinder certain sociocultural processes, including individual and group coping styles and abilities. McDoom (2012) discussed how threats to security could mobilise individuals to form new social groups. He proposed that the key influential factor was emotion, specifically, fear. In the context of a biosecurity incursion, fear can be associated with many facets of the outbreak and subsequent control or management processes (Mankad 2016). Cognitive perceptions of what is 'normal' or 'acceptable' within this unfamiliar social environment will also influence risk-related decision-making and coping mechanisms.

The present study examines how the threat posed by Panama Tropical Race 4 (TR4; an invasive fungus) is perceived by those most at risk and how individual coping responses and situational beliefs influence the emergence of new social in-groups and their attributes. Panama TR4 poses a significant and permanent biosecurity threat to *all* banana

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growers, as the disease affects all commercial banana varieties and remains live for many years. A shared threat such as this can affect group dynamics and personal values around risk, as well as cause subsequent social fragmentation where new social groups form during/in response to the disaster management process.

In this paper, our key research question is aimed at understanding how farmers are influenced by social norms in the way they react and adapt to changing circumstances brought about by a biosecurity incursion, their risk-related decision-making and the adoption of innovative biosecurity behaviours. This type of in situ social research has not been conducted in the biosecurity context previously; we have the potential to extend our understanding of how members of a social system perceive their environment and function within the new threat response landscape. The findings have important implications for managing and supporting social responses to future biosecurity disasters.

### 1.1 Bananas and Panama Tropical Race 4

Panama disease, specifically the Panama Tropical Race 4 (TR4) strain, affects bananas by entering the plant's roots via the soil and blocking the vascular system of the banana tree (Daly and Walduck 2006). The fungal disease prevents water uptake in the plant, causing leaves to discolour and wilt and produce sub-standard fruit, if any. The disease will gradually kill the host banana plant. While the fruit produced by an infected plant is not harmful to consumers, Panama TR4 spores are highly transmittable through the movement of soil and water, for example by birds or feral animals, via contaminated shoes or vehicles, or even the dispersal of infected matter via wind and water. Once in the soil, TR4 spores can lie dormant in the soil for around 30–40 years and, thus, will effectively halt banana production on the infected land (Plant Health Australia 2011). As such, Panama TR4 is considered a non-eradicable disease and consequently does not meet the requirements for formal financial assistance from agreed biosecurity protocols.

Panama TR4 represents an existential threat to global banana production and is, therefore, significant biosecurity threat to all Australian banana farmers if biosecurity action is not adequately adopted. Australia has experienced a variant of the fungus, Panama Race 1 (R1); however, its primary target was the Lady Finger banana variety. Panama TR4 has also previously been detected in Australia; however, until 2015, it was only present in the Northern Territory and under quarantine (Plant Health Australia 2011). In March 2015, the first Panama TR4 diagnosis occurred in the leading North Queensland banana-growing area, the Tully valley (Fig. 1). The North QLD banana industry supplies more than 90% of Australia's commercial bananas (approximately 334,000 tonnes in 2014), which equates to a farm gate value of \$600 million



**Fig. 1** Healthy banana trees in the Tully Valley, Queensland. Panama Tropical Race 4 affects banana plants' ability to uptake water through vascular tissue, thus resulting in discolouration, wilting and eventual plant death. (Source: Matt Cumock)

(Australian Banana Growers Council 2017). Therefore, the presence of Panama TR4 in this region poses significant economic and social issues for the region and for Australia's banana production as a whole.

The recommended management responses and biosecurity actions for the control of Panama TR4 range from relatively simple changes (e.g. installing a foot bath and putting up signage) to more significant infrastructure changes (e.g. fencing, vehicle washes). Broadly, the recommended biosecurity actions advised by the government (see Department of Agriculture and Fisheries 2015) cover the following:

- Controlled personnel movement
- Restricted vehicle and machinery movement
- Restricted roads and access
- Wash-down facilities for shoes and vehicles
- Fencing
- Tools and equipment hygiene
- Water supply, movement and disposal
- Farm waste management
- Farm-based animal movement

The guidelines also outline standards for crop and soil management, which includes standards for sourcing of tissue culture and general soil movement restrictions. Therefore, engagement with biosecurity practices can range from basic on-farm changes to a significant and integrated shift in practices.

### 1.2 The social context of a biosecurity incursion

In the aftermath of a disaster, many intra- and intergroup interactions can be beneficial, such as working together for a shared benefit or goal. However, in other cases, group interactions can create conflict due to inherently divergent

ideologies about how to move forward in managing a disaster and problem-solving. When a potentially negative ‘shared fate’ is introduced, such as a broadly applicable biosecurity threat, a once cohesive community can rapidly break or divide into more distinct and nuanced groups (Hornsey and Hogg 2000; Mankad et al. 2010). Group delineations can occur based on individual perceptions (or interpretations) of similarities and differences with others, for example shared views on the assessment of risk and consequent decision-making. However, it is important that the new groups are socially functional within the given context and that they facilitate adaptive individual action when required. For example, as is often the case with agricultural pests and diseases, effective protection relies on cooperation and co-management between individual growers, biosecurity agency staff and the local community. If existing groups are breaking down and new in-groups are forming around the biosecurity threat, then social divisions may inhibit an effective response (Fjelde and von Uexkull 2012).

*Self-categorisation* refers to circumstances where people view themselves and others as part of a psychologically similar group. Individuals categorise themselves based on salient social characteristics, which provide a context for the social environment and interactions within it (Turner et al. 1987). During this process of social categorisation, similarities within social groups are emphasised and differences between social groups are accentuated. There are various ways in which people can socially categorise themselves, but they typically involve either a personal identity, or a more inclusive social identity where the individual identifies with others (‘us’) in comparison to a salient out-group (‘them’). The *social identity* approach, as described by Tajfel, Turner and Hogg (Hogg et al. 2004; Tajfel and Turner 1986; Turner et al. 1994), is a psychological analysis of how the individual derives a sense of self from in-group membership and various intergroup relations.

Social identity theory proposes that we have an image or identity that we ascribe to ourselves in a given context and, accordingly, we use this identity to guide our social behaviour when that context becomes salient. As Hornsey and Hogg (2000) explain, when a social identity is activated within a particular group setting, an individual will express attitudes and strategies that align with the in-group, facilitating in-group loyalty, pride and a sense of superiority relative to the out-group. The salient social identity can be important when dealing with an environmental threat, as it provides social guidance for how an individual should interpret and cope with the threat based on how others in the group may be reacting. The social challenges posed by an environmental biosecurity threat, for example, will elicit dimensions of social identity which reflect attitudes towards on-farm behaviours and beliefs, perceptions of threat/risk and broader issues of trust, morality and public good. Shih et al. (1999) explain that individuals may even hold conflicting attitudes across contexts

and circumstances in the aftermath of a disaster, depending on how they interpret the threat event, which may result in new social categories emerging. This has the potential to create a complex social environment and the development of an ‘us’ versus ‘them’ mentality within affected communities. While we are not explicitly testing social psychological theories of identity and categorisation in this paper, we are using them to qualitatively structure our understanding of farmer behaviour post-incursion.

### 1.3 Risk perception

The role of self-categorisation in influencing risk perception and risk-related decision-making around biosecurity implementation is also explored in this study. Social psychology literature has consistently demonstrated that under conditions of low knowledge, people typically make decisions based on normative comparisons (Tajfel 1982). That is, individuals defer their own decision-making criteria in favour of the views of important others in their reference group. More specific to the present context, research shows that risk perceptions of environmental threats are also dependent on—and embedded within—a social context; thus, threats cannot be assessed independently of the social context (Frewer 1999). Actors presented with the same information about a threat, within similar social contexts, can also engage with risk variably (Curnock et al. 2017). For example, if important others in one’s social group believe that the risk of Panama TR4 spread is high, then individuals within that group will behave accordingly to minimise the risk.

While the predominant conceptualisation of biosecurity in agricultural literature is framed around biological risk (Mills et al. 2011), social research can help to improve biosecurity engagement outcomes by also considering social implications on biosecurity engagement. This can be achieved through an understanding of social contexts, including perceptions and attitudes of multiple actors and acceptance of the ‘shared responsibility’ idea of biosecurity governance (Curnock et al. 2017; Enticott et al. 2012; McAllister et al. 2017).

### 1.4 Present study

This study examines how new social categories and identities emerge within a post-incursion environment, where a biosecurity threat is perceptible but largely unknown. In this context, emergence refers to a natural occurrence where individuals socially align or cluster around key social properties (Thagard and Findlay 2012). We also explore how factors within the biosecurity context are valued differently between people within a previously cohesive group, causing the larger group (i.e. banana growers) to break down into smaller in-groups around a shared fate or issue (Hogg and Williams 2000). Prior to the Panama TR4 incursion, respondents

indicated that growers in the region were a largely cohesive community and shared a vision for a strong banana industry. However, most participants agreed that pre-incursion levels of biosecurity implementation were poor. There was a general belief that while TR4 was always a potential threat, it was a low-risk priority for farmers given the ever-present risk of devastating natural disasters and other crop diseases.

Post-incursion, growers may perceive Panama TR4 as threatening, but to varying degrees, depending on what information and values growers use to assess personal risk. As people strive to protect their properties and invest in resources, existing in-groups may disband due to ideological or perceptual differences in interpreting the biosecurity event; new groups may form around similarities specific to the biosecurity context. This social response to change can be used to better design on-ground engagement and extension activities during a biosecurity response, taking into consideration the different coping styles and risk profiles that exist amongst farmers experiencing a biosecurity threat.

## 2 Material and methods

### 2.1 Study region

Participants were from three dominant banana-growing communities: town A, town B and town C, in Far North Queensland, Australia (Fig. 2). The region is known for its many commercial banana plantations and sugarcane cropping; Cavendish bananas grown in this region represent approximately 90% of Australia's fresh banana crop. Thus, social and demographic characteristics within the region are dominated by livelihoods specific to farming and associated enterprises.

Banana growers in the region experience very similar climatic conditions, given the high density of banana plantations in the Tully Valley region and surrounds. The climate in this region is tropical and is prone to a monsoon-like wet season characterised by intense summer storms and severe cyclones. There is consistent evidence that people in this region typically band together as they collectively 'battle' natural disasters in a region prone to extreme weather conditions (e.g. Australian Broadcasting Network 2016). For example, at least three category-five tropical cyclones have affected the region in the past decade, causing severe localised damage to crops (Bureau of Meteorology 2017; Marshall et al. 2013).

### 2.2 Participants

Face-to-face interviews were conducted with 25 individuals representing farms in the banana-growing areas surrounding the townships of town A ( $n = 10$ ), town B ( $n = 7$ ) and town C ( $n = 8$ ), reflecting an overall response rate of 86%, based on the number of potential participants contacted. Participants

comprised farm owners, farm managers and farm employees. On the occasion where more than one person was interviewed from the same farm (e.g. farm owner as well as 1–2 farm staff), interviews were analysed separately to maintain independence. All participants were between the ages of 18–65 years and eight participants were female.

Participants were selected using a mixture of convenience and snowball sampling, due to the limited pool of eligible participants in the region; there are approximately 250 banana growers in North Queensland, not all of whom farm within our target region (Australian Banana Growers Council 2014). Therefore, this sample represents at minimum 10% of the available population of banana growers in North Queensland. Given the highly sensitive topic of a biosecurity incursion and the social apprehension surrounding the government's biosecurity response at the time of data collection, it is important to acknowledge that this study represents a case example of a horticultural community 12 weeks post-incursion. The authors do not claim that the findings reflect the views of all individuals in the region, but merely reflect the social interpretations and psychological attitudes of those who chose to participate under these circumstances.

### 2.3 Procedure

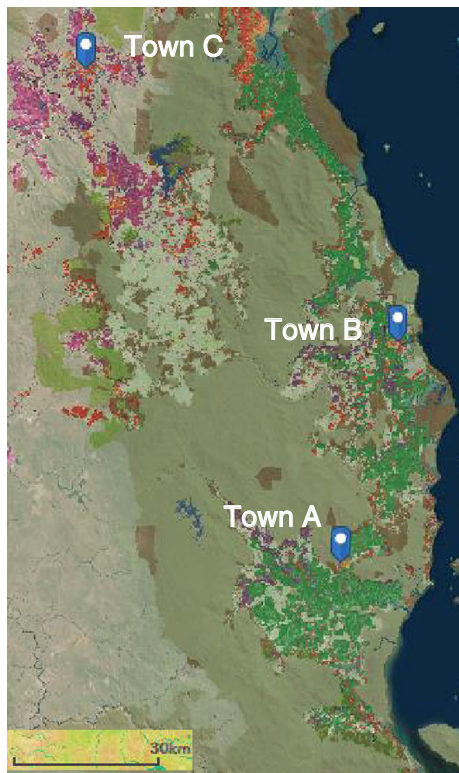
Interviews were conducted face-to-face on the participant's farm, typically in a banana shed/office, and lasted approximately 1 h per interview. A semi-structured interview design was used, to allow an open and easy discussion, given the sensitive topic of on-farm biosecurity. Key topics covered were the following:

- (a) personal perceptions and subjective knowledge of Panama TR4
- (b) biosecurity measures adopted on-farm, in response to TR4
- (c) social norms and comparisons
- (d) personal stress and coping, at present time

Interviews were audio-recorded with permission from interviewees and de-identified before being saved. These audio files were then transcribed verbatim for qualitative thematic analyses. This study received ethical approval from the relevant Human Research Ethics committee. Participation was voluntary and consent requirements were completed.


### 2.4 Data analysis

The overarching methodology of this research study was exploratory, using well-known social psychological principles to understand farmer behaviour rather than attempting to test an existing theoretical framework (Yin 1994). This is because there is little published literature on farmer behaviour *during*



**Fig. 2** Land use maps of the study regions in Far North Queensland. The dominant green shading represents banana plantations and cropping, typically sugarcane. A small blue marker represents the town centres

a biosecurity incursion or the social influence of coping during this time. Transcripts were analysed by two researchers in the project team. Participants' discussion content and associated key words were categorised independently by the coders and then compared based on thematic organisation. Words and statements were grouped based on their context and thematic relevance. Inter-rater comparisons were made to validate the analysis procedure and reduce interpretational bias; differences between coders were resolved through discussion. For this study, coding of data involved the identification and categorisation of themes based on attitudes and social identity alignment (inductive thematic analysis; Braun and Clarke 2006). Importantly, given this study was qualitative and exploratory, methodological validation was not concerned with seeking a large representative population sample, which would be subject to statistical analysis. Rather, the aim was to include a range of perspectives from the banana-growing industry near the infected property and the surrounding growing region. The final number of participants in this study was determined based on *data saturation* being achieved (Marshall 1996; Sandelowski 1995). Saturation refers to a completion of the analysis process when no new concepts are identified within the data. The ultimate sample size is, therefore, determined by data peak; traditional 'rules' about an appropriate sample size within a quantitative context should not be applied here.

 Dryland agriculture and plantations

(Source: Department of Science IT Innovation and the Arts (DSITIA) State of Queensland 2016)

**Data availability** The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

### 3 Results and discussion

Framing post-incursion social behaviour from the perspective of social categorisation in this study was integral to understanding social relationships amongst farmers post-TR4 diagnosis. Social identities were shaped by adaptive and maladaptive coping behaviours and threat appraisal of Panama TR4. In the behavioural sciences, coping behaviours vary in their direction and intensity. Adaptive coping is constructive and helpful in alleviating mental stress through problem-solving. In contrast, maladaptive coping is characterised by denial or avoidance behaviour which also relieves mental stress; however, these mechanisms are more likely to hinder the problem-solving process (Rippetoe and Rogers 1987; Umeh 2004).

Two dominant groups were evident in the aftermath of the TR4 diagnosis, based around coping responses and attitudes: the first group comprised growers who had rapidly engaged in positive biosecurity responses after the diagnosis was made public (*active adopters*,  $n = 15$ ). This group believed Panama TR4 to be a significant threat requiring immediate response. The second group (*passive adopters*,  $n = 10$ ) comprised

growers who acknowledged the threat of Panama TR4, but felt insufficiently informed of the personal risks (likelihood of harm). Consequently, they were more cautious in their investment of time and resources to the biosecurity response and displayed some avoidance tendencies. A small sub-group of *maladaptive* adopters also emerged within the passive adopter category who demonstrated more pronounced avoidant and helpless tendencies. Socially, it was clear that active adopters engaged with each other, attending various biosecurity meetings locally and sharing ideas. Passive adopters were less socially engaged with each other; however, they were aware of each other and did periodically exchange ideas on a one-on-one basis; maladaptive adopters, however, were more socially isolated.

A secondary social categorisation also emerged, which we framed as having an interactional effect on biosecurity adoption and risk perception. This influence was aligned with individual proximity to the TR4-infected property (IP1) and social identification with one's locality. Once again, there were two distinct groupings: growers from within the dominant growing area (town A) where IP1 was situation and those from outside the immediate quarantine area (town B and town C). While the regional cultural distinctions likely existed prior to the Panama TR4 incursion, consistent with locality and place of banana production, in-group/out-group identities and affiliations were activated post-incursion specifically around biosecurity threat management and risk-related interpretations of Panama TR4 (refer to Table 1 for a representation of the data).

### 3.1 Active adopters

'Active adopters' were the dominant social category to emerge in the wake of Panama TR4 being confirmed and formally declared. Participants classified as such were those who acted on their perceived threat of Panama TR4 and implemented biosecurity measures on-farm more readily than other growers. These growers recognised similar, proactive, biosecurity behaviours amongst some of their peers began to create a shared space to discuss shared beliefs around the TR4 response. More broadly, this process of encouraging like-minded community discussions effectively began to separate out those who felt highly threatened by TR4 and those who did not. It also meant that the risk profiles between the adopter groups became distinct, which had implications for broader biosecurity management. These informal group members described a strong feeling of vulnerability to the spread of TR4 and were typically from farms that were located closest to the incursion zone (i.e. typically from town A). Interestingly, this area is also where many of the medium and large banana-growing enterprises have their core production areas. The larger firms in particular have more sophisticated operations with progressive and up-to-date management protocols and biosecurity readiness. Thus, in addition to potentially

protecting a larger investment, these larger businesses likely had greater operational and financial resources to immediately implement biosecurity procedures on-farm. This increased capacity for adoption of biosecurity practices may well have influenced actual on-farm biosecurity adoption rates and added a socioeconomic dimension to the viability of individual biosecurity responses. Unsurprisingly, fear emerged as the most dominant driver for behaviour change amongst growers in this group. This included a fear of personal consequences in relation to the TR4 diagnosis and fear of the unknown risks (e.g. presence in the soil, spread rates) associated with Panama TR4 progression.

#### 3.1.1 Leadership, control and support

Given their willingness to participate actively in biosecurity-related behaviour change, active adopters perceived themselves (i.e. in-group members) as being 'leaders' and comprising 'the majority'. Active adopters felt a moral responsibility for championing the biosecurity response on behalf of the industry. Members of this social category expressed disbelief that others in their industry were not engaging in pro-biosecurity actions to the same extent. Active adopters typically expressed an overall feeling that individual growers must self-protect as much as possible, rather than rely on other growers' proactivity. This was reflected in sentiments that other growers (i.e. out-group members) were potentially letting the whole industry down. Irregular attendance or absence from town meetings was, consequently, seen as an out-group characteristic and undesirable for active adopters to exhibit. Active adopters also viewed the general public's lackadaisical response to the biosecurity emergency as reflecting out-group qualities. Many growers in this group felt let down by members of the general public who did not seem to understand the general community's roles and responsibilities in stopping the spread of Panama TR4. These external forces made 'active adopters' perceive a lack of control with respect to their own biosecurity efforts. Control was something that growers craved in an otherwise uncontrollable biosecurity context. Thus, gaining and maintaining *control* was identified as a significant motivator for individuals within this group and strengthened their desire to be seen as leaders controlling the fight against Panama TR4.

Active adopters valued the instrumental social support they gained from spending time and effort connecting with each other. Active adopters reported regularly attending local TR4 taskforce gatherings and town hall-style meetings and actively participating in biosecurity discussions. Being seen at these gatherings emerged as an important social tool and was a core identity characteristic for this group. Participants' responses indicated that attendance at these events was effectively a demonstration of commitment to the biosecurity response. The meetings also became a place where growers felt they could communicate with peers from their industry and learn/

**Table 1** Example quotes from within the data representing the two emergent social categorisations: early adopters and cautious adopters. Sub-categories/themes are also presented, with representative quotes from within the data. Coding of participants is given in parentheses to maintain anonymity of participants

	Quotes
<b>Description of active adopters</b>	
Leadership, control and support	There's a group of us that we consult each other [sic]. We're sort of like a committee but it's more loose than that. But if there is another sighting found we make sure we all know about it. [MC20] Had a few growers come and have a look [at vehicle wash]. It does have an influence. We're put down as industry leaders, so you want to try and set the example [MC12]
Efficacy and adaptive coping	We've put a lot of stuff in place the last few months to stop it spreading [MC11] I think we've got a chance, because of the practices adopted [MC15] Eventually it will turn up. You're not going to stop it. So for us, it's looking at other crops...It just comes back to looking at what you're doing. If you can do something a bit better, well let's attempt it, within reason too. You can't sell the farm just for one thing [AM1] [Panama TR4] is very scary. It has the potential to ruin the whole industry but if everyone does the right things, I think it's manageable and we can control it [MC16]
Trust	We have to put our trust in the people who have been employed to do it... But let's face it, you've got to protect yourself. You can't expect them to [MC13] I trust the protocol, it's my job to trust them, but first and foremost is to control this really within the farm, within the growers itself [MC2] The more people we help, the merrier. To keep this industry going you have to help. Help thy neighbour, isn't it?...It is [a competitive industry], but it's not going to be competitive if there's nothing there, is it? [AM2]
Normative comparisons	There will be farmers that won't do [biosecurity]. I don't know if it's a financial thing or it's out of laziness... [AM2] If I take that ute out, obviously we wash it down in the shed before it goes... and even around town I don't really see a dirty ute getting around town anymore... I would be too scared, everyone would be looking at you... It can build so much pressure on one person... [AM1] Our neighbours, we're doing things, they're doing things, we're probably in the same group... But I know in other areas there is definitely that segregation happening... a bit of angst between growers... [AM5]
<b>Description of passive adopters</b>	
Lack of knowledge, mistrust and response efficacy	...everyone is confused at the moment about the right thing to do and what to do. It's a real grey area... [MC3] I think they [Biosecurity agents] really need to have second opinions on it to get more credibility behind their science... [MC1] [Government] has dealt with it pretty poorly. I still don't have any faith in them... Even our own organisation, they have let us down early in the part. They weren't prepared to share any information with growers. We'd go to meetings and ... you really left those meetings uninformative. Lots of questions were answered but they were always talking around with a political nature. No-one was really giving any true facts. I felt like there had to be a lot more honesty towards the growers. They really let us down [AM5] From my understanding there is no real prevention, it's more prolonging not being affected... It's only a matter of time before everyone's affected [MC5] By simply putting a wash station out the front of your farm, it might make you feel good, but it's not going to stop it [MC8] There is no fool proof way because there is no way you can stop birds from landing... There is no guarantee that you can protect yourself [MC4]
'Doing all I can'	It comes down to economics... Doing what you can afford to do because it can be very costly... They've got to be workable. If they're not easy to implement, they won't be implemented properly [MC1] We've got structures in place to put down foot baths and wash down bays. But everything costs money and that takes time to do that sort of stuff [MC3] We just sort of try to do the best we can without really going over the top at the moment. If the risk increases, then we'll have to probably do a bit more [MC11]
Negative emotions and coping	To me it's a bit wild. It could come at any time, you don't know... I don't know whether they're telling you everything or not [MC9] Since it was in the [Northern] Territory we've always assumed that it was going to get here one day... It's always been put into the too hard basket. We're still behind, a lot of what we're doing now is superficial, it's rubbish really. [MC4] We can do the right things but if someone up the road isn't doing the right thing it's really defeating the purpose [AM3]

**Table 1** (continued)

	Quotes
Maladaptive sub-group	<p>To be honest, if it's showing its face now, obviously it's been there 10, 11, 12 months beforehand. Who knows...[MC1]</p> <p>You might already have it and you're spending all this money. Don't do it, don't spend it, it might be on your farm [AM5]</p> <p>We've been dealing with Panama Race 1 in our Lady Fingers for years and years so we already have the knowledge and the experience in dealing with it, which is exactly the same [MC1]</p>
Description interaction	
Proximity	<p>It's a bit of a worry. It threatens your job. I haven't lost any sleep over it but if it makes its way to [Town B] that could change [grower in Town B]</p> <p>We're downstream of where it was found... So if it's going to be transported, it's going to be by water... If you think about it too much you get depressed [grower in Town A]</p> <p>We can do avocados, blueberries. We're in a really diverse area... [Town A] would be a totally different story. They would only be able to go into cane or cattle [grower in Town C]</p>
Place identity	<p>Most of the farmers in this area have worked well together. I can only speak on the [Town A] district, I don't think [Town B] has the same, it's a different dynamic [MC12]</p> <p>I think in [Town B] ... it's a huge culture difference. You've got the [migrant groups] and so on. In [Town A] you do have some [migrant] farmers but it's mostly Australian people and they've been there for generations. There is a farm over here that has been changed over 10 times in the last 10 years and it changes over very quickly... So for [Town B], it's a worry if [Panama TR4] breaks out here [AM1]</p> <p>[Town A] is different to [Town B]... [Town B] has got a lot of small growers... In [Town A] we're all larger growers, the majority of us, and we're all neighbouring in some situation. Some have got two farms down here; some have got more... we're all neighbouring, so we all get on [MC21]</p>

share innovative strategies for on-farm biosecurity. Growers in the active adopter group prided themselves on their innovative solutions to the biosecurity problem. They developed many of their on-farm mechanisms through trial and error, as there were no formal manuals or detailed implementation instructions to follow, only general guideline 'recommendations' by the local biosecurity authority. This sense of mentorship and providing social support to others added to active adopters' identities as being industry leaders in the Panama TR4 biosecurity response.

Research by Mankad et al. (2017) in the context of psychosocial barriers and facilitators of biosecurity engagement found that leadership was a key driver of action amongst farmers. The role of these biosecurity 'champions', who were typically more established and/or larger enterprises, was to innovate and lead adoption of novel pest management strategies. They also were seen as supportive role models for smaller growers. Mankad et al.'s findings are consistent with the current results, where active adopters were predominantly from larger businesses and viewed themselves as leading biosecurity efforts on the ground.

### 3.1.2 Efficacy and adaptive coping

Active adopters perceived a high level of efficacy for the effectiveness of biosecurity responses recommended by governing biosecurity representatives (response efficacy) and personal confidence in performing the required tasks (self-

efficacy) (Mankad 2016; Rippetoe and Rogers 1987; Rogers 1983). Proactive growers demonstrated initiative by engaging early with many of the preliminary administrative tasks recommended in their biosecurity manuals (e.g. visitor sign-in, staff education, signage). By 3 months post-diagnosis, owners/managers categorised as active adopters reported that they had briefed staff about what they knew of Panama TR4, placed signage around their property boundaries and implemented new work plans designed to minimise the disruption and spread of soil around farm areas. These changes also included constructions such as disinfecting foot baths and machinery washes, site-specific footwear practices and strict equipment protocols. Farmers expressed confidence in the industry-recommended biosecurity activities and believed these on-farm mechanisms could safeguard against the spread of disease. Active adopters also expressed a view that there were many initial responses that could be implemented at 'low cost', but that most of the cost was in terms of growers' time and effort. Most discussed the significant time they dedicated to planning the best ways to manage biosecurity changes on-farm, targeting high-risk transmission pathways first and steadily implementing more mechanisms as time went on and more funds became available. This time cost was not perceived as onerous, but rather, as a valuable and necessary component of adequate and effective biosecurity planning. On-farm implementation of innovative biosecurity solutions and initiatives is clear evidence of adaptive coping by active adopters post-incursion.

Further evidence of adaptive coping amongst active adopters emerged through the development of farm diversification plans for the future. Growers who had land suitable for the production of other crop types reported that they were already looking to broaden or change their dominant crops in the months after the Panama TR4 diagnosis. Those growers who did not have land suitable for other horticultural crops were still thinking adaptively and developing ways to optimise current banana production and diversifying in other ways. Other adaptive coping skills displayed included a positive attitude about the future, information-seeking behaviours and motivation to actively protect one's property and business rather than passively reacting to external influences. Underlying this group characteristic was the importance of *competence*, a key psychological driver of action; Ryan and Deci (2000) frame competence as a basic psychological need in the facilitation of personal well-being. The present results show adaptive coping characteristics revolving around confidence and capacity in carrying out biosecurity activities, regardless of what they were. The agricultural literature is peppered with examples of how personal feelings of competence (i.e. efficacy) can influence uptake and implementation of novel farm solutions (e.g. Falk et al. 2008; Roy 2009; Van den Berg and Jiggins 2007).

### 3.1.3 Trust

Trust emerged as a multi-level construct amongst active adopters. Individuals expressed interpersonal trust amongst members of their in-group who were actioning biosecurity protections and 'doing the right thing'. Interpersonal trust amongst growers within the in-group was high, and participants talked about trusting other farmers as valuable sources of information about Panama TR4, learning from their biosecurity practices. Yet, participants also acknowledged the simple fact that growers were ultimately each other's competitors, vying for the same market access, which had undermined previous efforts to work collaboratively. However, the safety and longevity of the banana industry was of greater importance to most participants than trying to outperform their peers once the Panama TR4 diagnosis was made. This superordinate goal was a priority for active adopters.

There was an underlying weariness about the government-led biosecurity response. This was reflected in growers' reluctance to leave the biosecurity efforts to the 'professionals' and their desire to take on an active role in the biosecurity response. Most active adopters, however, did show trust in the plant science and believed that the Panama TR4 diagnosis was accurate; certainly, they did not question the validity of the diagnosis in the same way that 'passive adopters' did. Of those who were a bit less certain that the disease found was TR4, they still chose to act because of a common belief that

regardless of the diagnostic certainty, Panama TR4 was too high a risk to ignore on-farm biosecurity protection. Participants in this group were also in agreement that although there could be various reasons as to why Panama TR4 was found in the region (North Queensland), no individual grower should be blamed and, ultimately, the banana industry as a whole was to blame for its lack of biosecurity preparedness. There was admiration expressed for the grower who did report his infected plants, acknowledging that his actions, while undoubtedly personally devastating, were for the greater good of the Australian banana industry.

Active growers also spoke of trust in governance, which underpinned farmers' beliefs in the effectiveness of biosecurity responses recommended by governing authorities. Most growers in this group expressed a high level of trust in their representative biosecurity agency and/or their peak industry body. Yet, there was a clear distinction between trust in recommended biosecurity protocols and institutions, as opposed to trust in government biosecurity personnel; trust in the latter was conveyed more as a leap of faith that the government had the right people managing Panama TR4, rather than a staunch belief. Further, while most active adopters outwardly complained very little about political issues, there were a few who expressed displeasure at the government's handling of the Panama TR4 incursion thus far. In particular, participants believed that government inspectors were poorly treating those growers who the government had deemed 'high risk' (i.e. growers connected to the infected property in some way), as well as the general insensitivity displayed by government personnel towards the farming community during a time of intense personal stress. Both issues were seen as devaluing grower contributions to the biosecurity effort and contributing to an overall decline in public trust of the government's biosecurity management.

Past research on biosecurity surveillance, reporting and management (e.g. Gunn et al. 2008; Palmer et al. 2009; Schemann et al. 2012b) has demonstrated that trust is a key contributor of not only preventative surveillance but also willingness to adopt recommended biosecurity practices. An interesting comparison can be made between the current Panama TR4 incursion and the equine influenza outbreak in Australia (Schemann et al. 2012a). After the EI outbreak, a large number of horse managers agreed that there was successful eradication of equine influenza due to the overarching biosecurity implementation strategy; trust in Government personnel and their on-ground management was variable. However, horse managers did highlight perceptions of 'good' and 'bad' experiences, indicating that there was inconsistency in the delivery of information by the leading government agency. This contributed to poorer trust amongst some managers, particularly those who were commercial stud managers and were disproportionately affected by the biosecurity-related movement restrictions placed on horses.

### 3.1.4 Normative comparisons

As highlighted in section 1, maintaining in-group identity required individuals to periodically compare their behaviour with those inside and outside their referent group. Thus, amongst active adopters, there was a high level of social appraisal and comparison of peers. Active growers had a heightened awareness of what others were doing on their properties to combat the spread of Panama TR4. Several growers indicated that this social comparison was also tied to social approval from in-group members. Participants felt a normative pressure to ensure their individual actions ‘fit in’ with what important others were doing. Thus, commitment to implementing key biosecurity behaviours on-farm achieved the dual purpose of allowing individuals to be proactive in managing the threat of Panama TR4, as well as visibly demonstrating to others that their behaviours were aligned with a desirable ‘proactive biosecurity leader’ social identity. People in this group were also morally driven and expressed little doubt that they would report any suspect plants on their farms ‘for the greater good’, despite the likely negative impacts.

Relatedly, there was an awareness and identifiability surrounding those growers who did *not* fit in with the in-group identity. Active adopters were cognisant of the social pressures that these ‘others’ likely felt in choosing not to conform to the dominant proactive ethos. Active adopters also displayed empathy towards those who could not implement any changes due to financial limitations and acknowledged that many people would be going into heavy debt if they implemented all the recommended behaviours on-farm. However, active adopters equally held an expectation that regardless of financial liquidity, like-minded others should be committed to doing all they could to combat the spread of Panama TR4 and, at the very least, stay informed and engaged with the biosecurity response. There was a clear perception amongst active adopters that those individual growers who purposefully behaved contrary to biosecurity recommendations, or did nothing to contribute to the biosecurity response, were problematic and not acting in the interests of their industry peers or the community. This finding is consistent with other social norm research in agriculture, where farmers typically rely on socially normative information when making decisions to respond to risk and uptake of novel practices (e.g. Garforth et al. 2013; Hu et al. 2006; Mankad 2016). The findings also align with the notion of in-group superiority identified and described in the social psychology literature (e.g. Hornsey and Hogg 2000).

## 3.2 Passive adopters

Participants who were categorised as ‘passive adopters’ were not dissimilar from ‘active adopters’ in their perception of threat *severity* of TR4. Most were willing to implement at least

some basic biosecurity activities on their property. This again aligns with the equine influenza example discussed earlier (Schemann et al. 2012a), where all horse managers recognised the threat posed by the incursion. However, the biosecurity behaviours that passive adopters engaged in, in the present study, seemed to be a reflexive response driven by a fear of Panama TR4, rather than responding to a perceived personal *vulnerability* to TR4. Therefore, the main difference between active and passive adopters was their interpretation of risk and decision-making around biosecurity which ultimately influenced their uptake behaviour. Most passive adopters were investing moderately in on-farm mechanisms to protect their farms (e.g. foot baths, signage), yet underlying attitudes towards biosecurity in response to Panama TR4 indicated that this group was largely unconvinced that they would be personally affected by TR4. They remained apprehensive of Panama TR4 and were wary of investing too many resources in managing the risk of disease spread.

Another key difference between passive adopters and active adopters was their general locus of control when attributing risk pathways. For example, passive adopters perceived the general public as a significant threat to the biosecurity response to Panama TR4, just as the active adopters did. However, when active adopters mentioned the risky behaviours of others, their focus was more internal and concerns were discussed in the context of how this increased risk would be relevant to modifying their own on-farm behaviours. In contrast, passive adopters expressed a more external locus of control and focused on the risky behaviours of others as contributing to a personal sense of helplessness. An external locus of control promotes the idea that things happen to an individual through luck or fate, which inherently ascribes a low level of control for the individual (Ajzen 2002). This difference in perceived control is a key distinction between the groups’ coping styles. Where active adopters demonstrated adaptive coping mechanisms (i.e. internal locus of control), passive adopters demonstrated more maladaptive coping responses (i.e. external locus of control).

### 3.2.1 Lack of knowledge, mistrust and response efficacy

Passive adopters perceived a lack of information on the disease itself, as well as its likely progression and effects, and this seemed to influence their perception of risk. Knowledge was put forward as the fundamental precursor to action and, thus, lack of knowledge was used to justify a lack of more complex on-farm changes. Passive adopters created an identity around this feeling of being ill-informed and not having access to enough credible information, which resulted in them being less likely to implement certain biosecurity recommendations on-farm. Where active adopters engaged in trial and error behaviours, passive adopters made conservative assessments of the biosecurity context and speculative assessments of how

greater investment in biosecurity might negatively affect them. Individuals in this group consistently reported that they rarely received any new information at community meetings and felt that the media knew of TR4 developments before the farmers did. This was described by growers as a flawed situation and participants felt the media sensationalised any information it received, highlighting an inherent mistrust in the media. Participants in this group were also very weary of gossip amongst growers. Many indicated that they had heard ‘lots of conversations’ about Panama TR4 and its symptoms, how it arrived, the testing procedure and how it was treated, but were sceptical of the accuracy of this type of information.

Many in this category also believed that if their plants were not showing signs of Panama TR4 to date, then they were likely ‘ok’ for now. Others expressed inaccurate representations of knowledge about Panama TR4 and its impact on banana production, as well as erroneous extrapolations from past experiences with Panama R1. These growers identified themselves as ‘old hands’ or experienced farmers who dealt with disease threats calmly, rather than responding to what they considered ‘panic’ and a sudden interest in biosecurity. The overall sentiment was that much of the information ‘going around’ should be interpreted cautiously as it was not the most reliable information and akin to gossip. Thus, individuals in this group positively distinguished themselves as selective, information-seeking people who valued scientific evidence around the disease and efficaciousness of the recommended biosecurity responses. They described their thoughtfulness and lack of blind faith in the science as desirable social attributes. Further, it was seen as prudent to question the credibility of the biosecurity governing authority and ensure that one was not being ‘hoodwinked’ about the realistic threat of Panama TR4. Mankad et al. (2017) also found that growers’ suspicion around governing bodies was related to a perception that the government only had short-term interests in novel pest management strategies. This negatively influenced growers’ stated intentions to participate in new management practices.

Arguably, these growers may well have been ‘active adopters’ within the context of Panama R1. However, in the context of TR4, their prior investment in biosecurity for Race 1 seemingly absolved personal responsibility for engagement in further action in response to a new, distinct threat. Thus, prior experience with a Panama incursion was actually a barrier for these individuals to move forward with the biosecurity engagement and limited their capacity to take on new information.

### 3.2.2 ‘Doing all I can’

Despite the perceived lack of information available to them, passive adopters inherently believed they were doing the right thing to control the spread of Panama TR4 as best they could. Their conservative engagement in biosecurity was typically

explained as a temporary ‘holding pattern’ until they felt confident in their level of knowledge about the situation. Similar to active adopters, passive adopters trusted themselves to manage the Panama TR4 outbreak above anyone else. Participants were willing to invest some time and money into implementing biosecurity measures on-farm, but only if they felt that those recommended changes were reasonable and evidence-based, or easily integrated with current behaviours. If not, then growers were clear that this lack of integration would negatively influence their adoption. For example, passive adopters were willing to make some modifications to their day-to-day activities (e.g. foot baths, vehicle wash areas), but were unwilling to make major on-farm changes (e.g. installing perimeter fencing, integrated vehicle washes) at this ‘early’ stage of the disease response. This limited engagement is also likely linked to perceptions of competence and capacity in carrying out more complex initiatives, as discussed in section 3.1.2 (e.g. Ryan and Deci 2000). It also aligns with findings from research on area wide management, where growers were more likely to engage in novel biosecurity practices only if they were compatible with existing farm procedures (Kruger 2017; A. Mankad et al. 2017). Given how time-poor farmers are, alignment of new pest management strategies with current on-farm practices was a key enabling factor of widespread uptake.

Interestingly, when asked to talk about personal intentions to report suspicious plants, passive adopters expressed mixed feelings. There was clear concern for the potential negative consequences of reporting on one’s business and reputation. Some passive adopters felt that they would certainly report a suspicious plant because of the broader impact on all growers; that is, individuals felt a moral responsibility to report any incidents. However, others were less convinced that reporting a suspicious plant was in their best interests and were motivated more by individually oriented factors; hesitation around reporting was justified by explaining that it would need to be a business decision, rather than a moral one. This narrative of growing bananas as a ‘business’, rather than describing it as a livelihood, was a common and salient feature of the passive adopter category. By viewing banana-growing as a business, growers were able to compartmentalise and externalise biosecurity uptake decisions. In doing so, these individuals were able to protect and temper their emotional response to this significant incursion.

### 3.2.3 Negative emotions and coping

On the surface, coping behaviours amongst passive adopters were similar to active adopters; that is, they believe TR4 to be a threat and were implementing some changes on-farm. However, passive adopters were directing their efforts towards different priorities or value propositions. While active adopters were actively installing complex on-farm

mechanisms and developing ways to diversify, as a means of adaptively coping and seeking to gain some control, passive adopters were prioritising ways to retain their core banana business and acclimatise to the changing banana-growing circumstances. There was a higher level of negative emotions such as stress evident amongst passive adopters, likely due to an increased level of perceived uncertainty. Yet, in most cases, this stress was adaptively driving some engagement in biosecurity activities. People within this group seemed less influenced by social assessments and normative comparisons from others and felt that they could justify their cautious investment in biosecurity based on sound decision-making around their perceived risk. Passive adopters did, however, indicate that if authorities could provide credible evidence convincing them that the threat was ‘real’, then they intended to commit more investment in biosecurity protection. Alternatively, if this evidence ‘proved’ the threat to be false or inconsequential, then their adherence to stringent on-farm biosecurity practices would likely wane.

Fear was another negative emotion represented in many ways amongst passive adopters. For example, fear of mismanagement by authorities was associated with lower intentions to report any suspect plants on individual properties. Participants felt that the reporting and quarantine procedures in place, post-outbreak, were inefficient and caused unnecessary production loss and extreme personal stress. This was based on observational or vicarious experiences of affected peers. A general lack of knowledge regarding Panama TR4 also contributed to overall feelings of fear amongst growers, mostly fear of the unknown (e.g. ‘do I have Panama TR4’, ‘how do they know it’s Panama TR4’, ‘what will happen to me if I have it’). The role of emotions has been shown to be persuasive in risk-related decision-making (Böhm and Brun 2008). This is particularly the case when the extent of thinking within a decision-making context is constrained to be low (e.g. poor knowledge of Panama TR4); in this case, emotions can drive attitudes in a way that is consistent with the valence (e.g. positive or negative) of the emotion (Petty and Briñol 2015).

Interestingly, passive adopters were not only fearful of poor incursion diagnosis and management, but they were also worried of not abiding by biosecurity recommendations at all (i.e. the cost of inaction). This helps to explain some of the more reflexive biosecurity activities implemented on-farm by passive adopters, where some growers implemented changes that were driven by uncertainty rather than conviction. Often, the biosecurity behaviours that passive adopters engaged in were rote and designed to meet requirements, rather than coherent and planned biosecurity response procedures for the farm. These results align with past evidence that shows how past experiences with a biosecurity outbreak can influence perceptions of vulnerability to a future outbreak and facilitate favourable intentions to implement future biosecurity measures (Schemann et al. 2013). It may also be that for some

growers, the Panama TR4 incursion was viewed as a relief, allowing burned out or disengaged banana growers to view Panama TR4 as an opportunity to pursue other things. While this alternative interpretation is not ideal for a successful biosecurity response for Panama TR4, psychologically speaking, this type of alternative framing as a means of coping with Panama TR4 is still considered a form of adaptive coping (Montero-Marin et al. 2014).

### 3.2.4 Maladaptive sub-group

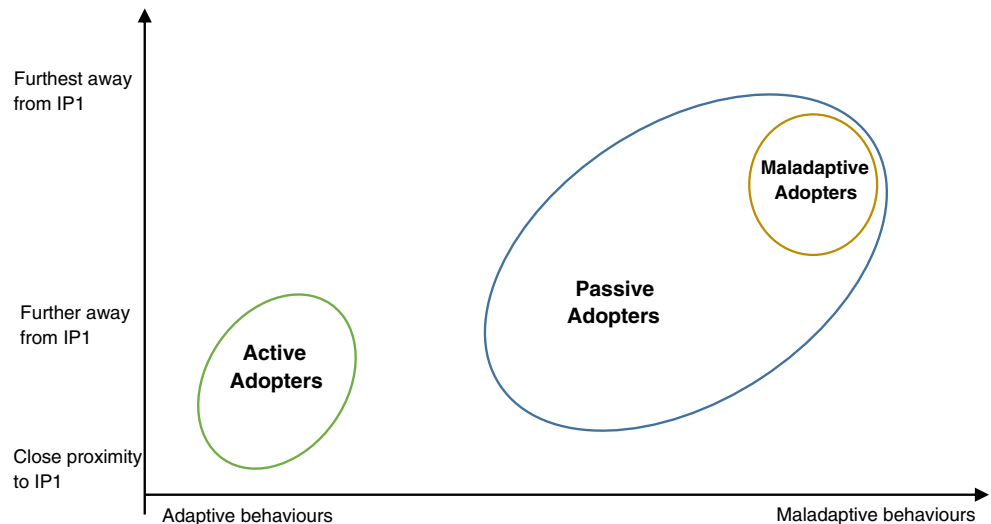
Interestingly, there was a small proportion of passive adopters who demonstrated clearly maladaptive coping skills, characterised by perceived helplessness, denial and lack of information-seeking behaviours. Figure 3 provides a simple conceptual illustration of the dominant groups as they relate to proximity with IP1 and how the maladaptive sub-group was conceptualised. Maladaptive adopters believed that while Panama TR4 was a significant threat to banana crops, it was unlikely to be managed successfully given the ease with which Panama TR4 could spread and the inadequacy of recommended on-farm changes. Amongst these individuals, there was a sense of inevitability (helplessness) about TR4 spreading which seemed to prevent them from engaging effectively with the response and with their more proactive peers. There was also an element of denial that biosecurity action could manage the spread of TR4 in any way. For example, participants scoffed at the notion that TR4 spread could be contained, given how wildlife (e.g. birds) could easily access banana properties and carry soil across banana farms.

Denial and helplessness, along with avoidant behaviours and negative emotions, are psychological states that fit within a broader conceptualisation of negative mood, of which depression is the more severe form (Maier and Seligman 1976; Seligman and Peterson 2001). Although very few participants in our total sample displayed these extreme maladaptive qualities, the presence of such beliefs within our data suggests that a valid and distinct social subcategory of ‘maladaptive non-adopters’ may also exist within the broader banana-growing population that comprises as a small but significant proportion of growers. Relatedly, all participants in our sampled demonstrated negative emotions in response to the TR4 diagnosis, which suggests that a broader examination of negative moods and stress may provide greater context for biosecurity uptake during an incursion and for the management of grower well-being (Enticott and Vanclay 2011; Mankad 2016).

### 3.3 Interacting factors: proximity to IP1 and place identity

On examining the roles of (a) proximity to the infected property and (b) place identity (i.e. strength of personal identity

**Fig. 3** A simple visual representation of how social categories were typically distributed along a simple coping continuum from adaptive to maladaptive (*x*-axis) in relation to perceived proximity to the first Panama TR4-infected property (IP1). Note that the axes are not intended to reflect a quantitatively accurate representation of distance or behaviour



and pride associated with the local growing region), we found that while these factors were not dominant drivers of risk management behaviour or coping strategy, they did seem to interact with a farmers' adoption of biosecurity measures and risk-related decision-making. From our interviews, proximity and place identity appeared inter-related and there was a clear cultural distinction described within the grower narratives relating to the sociocultural differences between town A (where the first infected property was located) and other banana-growing areas. Specifically, cultural and behavioural differences emerged as part of a location-based identity, which seemed to contribute to the social distinctions. Typically, there was a sense that most of the growers from town A were part of at least medium-sized enterprises and, consequently, had the most to lose in the event Panama TR4 were to spread. This was also consistent with a perception that these growers likely had greater capital to spend on implementing new biosecurity systems on their properties. We identified a higher proportion of active adopters in town A and a higher proportion of passive adopters in the other growing areas (towns B and C).

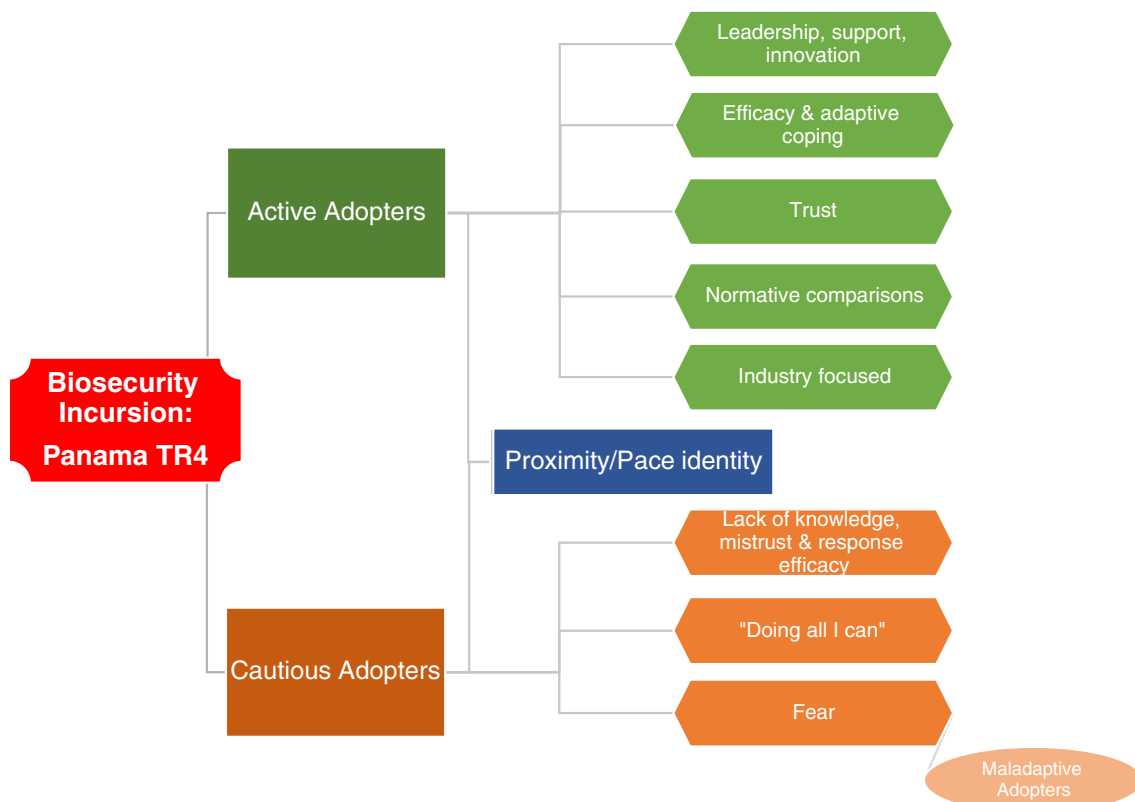
Across the three growing regions, when participants spoke of their farm's relative proximity to the first infected property, it was typically in the context of how vulnerable they felt to the possible spread of Panama TR4. Participants also used this relative proximity in gauging the level of risk on their farm and farm behaviours and used this to determine the force of their biosecurity strategies. In general, while all growers believed Panama TR4 to be a significant risk to the banana industry, growers living outside town A expressed less perceived vulnerability to Panama TR4 than those growers living within town A. Therefore, location was certainly a salient factor that consistently emerged as a contextualising variable and cannot be overlooked as an influence on the social experience

post-incursion. Figure 3 demonstrates how the two groups were inter-related with location.

### 3.4 Summary

The results from this study described the formation of two distinct social categories within a banana-growing community, each valuing different aspects of the social landscape post-biosecurity incursion (Fig. 4). Individuals expressed this through their subsequent coping styles, risk-related decision-making and behavioural management of the Panama TR4 threat. Proximity to IP1 and place identity (which were indistinguishably linked) appeared to play an interacting role in growers' expression of adaptive behaviour, but were not themselves dominant drivers of active or passive biosecurity adoption. The main factors driving social groupings post-incursion were as follows: perceived risk associated with Panama TR4, individual coping styles, attitudes towards biosecurity, perceived efficacy of recommended behaviours/practices for managing the spread of Panama TR4 and knowledge of the disease circumstances. It was also clear throughout the interview process that growers were also influenced by beliefs about what others were doing and what was morally right and the level of trust/distrust in available information, when deciding how to respond to the TR4 threat. Thus, a key characteristic amongst participants in the post-incursion environment was a high level of social awareness and normative comparison. While some growers used social comparisons to guide their own behaviours in a positive way, others downwardly compared as a defensive coping mechanism (Festinger 1954; Wills 1981) (Festinger 1954; Wills 1981).

For some, the most appropriate response to the TR4 threat was to gain a sense of control in a highly unpredictable environment. For the subset of *maladaptive adopters*, the decision *not* to act was, in a perverse way, also a means of maintaining



**Fig. 4** A summary of social categories emerging across communities affected by a biosecurity incursion (Panama TR4), 3 months post-incursion

personal control of the situation and retaining independence. That is, choosing not to act was as personally and socially powerful as choosing *to* act for some. This also meant that across the broader sociocultural context, interactions between those who socially identified as characteristic of active adopters and those who did not were seemingly strained, with anecdotal reports of threatening behaviour and verbal stoushes in both public and private forums. Intergroup conflicts such as these are often based around the in-group and out-group distinctions and can result in discriminatory behaviour. In particular, groups perceived as holding views in a minority are often targeted due to the strength in numbers of other groups. In the present context, it was evident that those growers categorised as *maladaptive adopters* were positioned as a social group expressing minority views to the detriment of their social status; this may have prevented others with minority views from coming forward and participating for fear of social retribution. Participants were socially aware of how growers in the minority group were perceived by other more influential growers. Some described instances where those in the minority group were subjected to negative behaviour by others. With livelihoods at stake, the need to derive meaning and confidence from active participation in biosecurity was potentially a catalyst for social behaviours that promoted conditions for a majority group and weakened a minority group who did not share the same commitment to a standardised biosecurity response.

Given the contentious social environment for those expressing minority views (e.g. protecting against Panama TR4 was a waste of time), an important consideration to acknowledge is the possibility of a self-selection bias in this study. Those farmers who felt that their personal values were not aligned with the majority may have avoided activities where they would be required to express views on biosecurity and disease control. Consequently, the likelihood of individuals opting out of participation in this study may have been more prevalent amongst those were representative of maladaptive adopters, or another type of social category represented by only a small proportion of growers. Therefore, findings from the present study must be interpreted in the context of understanding the potential bias for active adopters within a biosecurity incursion context and the inherent social undesirability of being 'the odd one out'.

## 4 Conclusions

A key advantage of this research is providing an understanding of individual factors that drive social interactions in the aftermath of a significant biosecurity incursion. In the case of Panama TR4, our study can assist biosecurity authorities and extension officers in improving their engagement and communications with stakeholders (e.g. growers) on the ground by

being aware and responsive to social norms associated with different adoptive typologies. This could be achieved via:

- more targeted communication
- encouraging early biosecurity uptake by incentivising desirable behaviours
- normalising a pest management culture
- developing financially sensitive approaches that are viable for those smaller enterprises who cannot participate fully and instead look for other, more maladaptive ways, of gaining personal control

The present study also demonstrates that instrumental social support is important to the advancement of adaptive coping and increased biosecurity implementation. Social support can be used as a way to strengthen cohesion across different social groups and encourage interdependence and contact between peers who may not ordinarily interact. Experiencing support from those with different attitudinal perspectives may encourage people within distinct identity groups to develop a greater sense of awareness for the broader social context and could be a crucial way of promoting overall community cohesion during a period of high stress (Packer and Chasteen 2010). Ultimately, the goal of understanding social interactions during and after a biosecurity incursion is to develop ways of promoting a social environment where adaptive coping and problem-solving skills are high. These are hallmarks of a highly resilient community, where there is greater trust and value in the biosecurity management process, lowered personal stress and increased feelings of well-being. A clear limitation of this research is that we could not collect the views of *all* growers within this region; thus, more nuanced social groups may exist and represent different grower typologies that emerged in the wake of a biosecurity incursion. It is recommended that future research examine how important threat and coping appraisal are in predicting biosecurity uptake, the influence of emotion and stress in biosecurity engagement, and the impact of social support on social well-being and resilience in the aftermath of a biosecurity event.

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### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Human research ethics** This study received ethical approval from the relevant Human Research Ethics committee.

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