The Canterbury Earthquakes:
The Impact on Farming Organisations

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1 Introduction

On 4 September 2010 the Magnitude 7.1 'Darfield' Earthquake marked the beginning of the Canterbury earthquake sequence. The Darfield earthquake produced strong ground shaking throughout the central Canterbury Plains, affecting rural areas, small towns and the city of Christchurch. The event produced a 29 km long surface rupture through intensive farmland, causing localised flooding and liquefaction. The central Canterbury plains were subjected to a sustained period of thousands of aftershocks in the months after the Darfield earthquake1.

The primary sector is a major component of the in New Zealand economy. Business units are predominantly small family-run farm organisations2, though there are increasing levels of corporate farming. The agribusiness sector contributes 20 per cent of real GDP and 47 per cent of total exports for New Zealand3. Of the approximately 2,000 farms that are located in the Canterbury Plains, the most common farming sectors in the region are Mixed farming (mostly comprised of sheep and/or beef farming), Dairy farming, and Arable farming (cropping)3. Many farms on the Canterbury Plains require some form of irrigation and are increasingly capital intensive, reliant on built infrastructure, technology and critical services6.

Farms are of great significance to their local rural economies, with many rural non-farming organisations dependent on the health of local farming organisations4. Despite the economic significance of the sector, there have been few, if any studies analysing how modern intensive farms are affected by earthquakes.

The aim of this report is to (1) summarise the impacts the Darfield earthquake had on farming organisations and outline in general terms how farms are vulnerable to the effects of an earthquake; (2) identify what factors helped mitigate earthquake-related impacts. Data for this paper was collected through two surveys of farming and rural non-farming organisations following the earthquake and contextual interviews with affected organisations. In total, 78 organisations participated in the study (Figure 1). Farming organisations represented 72% (N=56) of the sample.
Observed Impacts of the Darfield earthquake

Immediately after the Darfield earthquake there were significant concerns of widespread impacts to the Canterbury agricultural sector and rural communities. The effects of the earthquake varied significantly between different farming sectors, the level of ground shaking or liquefaction experienced and pre-existing state of individual organisations.

Farming organisations were most affected when the core base of production was impacted (e.g. damage to crops or livestock). Attention immediately focused on farms located on the 29 km fault scarp, who had to contend with damage to land and farm infrastructure due to the ground deformation. Farms impacted by liquefaction ejection to the south-west of Christchurch were also seriously affected.

In the months following the Darfield earthquake, farming organisations identified the most disruptive impact to be the interruption of electrical services. For dairy farming, dairy sheds (the structure where the cows are milked) are only operable with electricity and the health of the cows is compromised when they are not milked at least once a day. Other disruptive impacts cited by the majority of farms were the interruption of water service (either due to well damage or breaks in water lines), structural damage, and non-structural damage. Some examples of these damages can be seen in Figure 2.

The majority of farming organisations reported being "affected in some way" were located approximately 20 km from the fault surface expression. On-farm infrastructure that sustained structural damage included grain silos, residential houses and milking sheds (Figure 2). In some cases, structural damage was a direct result of liquefaction, but was usually isolated. Non-structural damage was generally attributed to ground shaking, as
was damage to irrigation lines. Fence-lines were damaged in areas where surface deformation or fault offset were observed. Damaged fence-lines created significant livestock management issues, and also threatened crop for arable farming. Farming organisations located proximal to the fault scarp observed new hills, scarps or cracks. Only 13 per cent of farms sampled reported observing liquefied material deposits. Importantly however, liquefaction reduced farm performance by damaging topsoil\(^7\), which limited dry matter production capacity and available feed for livestock. Other patterns of deformation reported were changes in the water table which caused flooding in localised areas, surface cracking, changes to farm boundary lines, and in one case, surface flooding caused by the fault scarp’s vertical displacement of a river channel. Localised flooding has been shown to decrease paddock productivity, reduce access to feed, and threaten livestock\(^8\). One-third of the farms that experienced ground deformation found that the ground deformation continued to change 1 month following the event.

![Figure 2: Examples of earthquake-related impacts to farming organisations following the Darfield earthquake. (A) Damage to buried irrigation infrastructure (B) two grain silos strapped together due to listing in opposite directions. (C) Damage to dairy shed concrete block. (D) Paddock surface flooding. (E) Fence damage and fault offset. (F) Deepening of river channel due to scarp offset. (G) Liquefaction deposits ranging in particle size from silt to cobbles. (H) Surface fault rupture through paddock and irrigation channel.](image)

While the effects of an earthquake can vary between different farming sectors, all farming sectors exhibited similar levels of disruption. Dairy farms reported to be most affected by electricity disruption and structural damage. Mixed and arable farms were most significantly affected by the interruption of water services. The degree to which farms were affected by water interruption, or natural disasters in general, is time-sensitive as farming vulnerabilities change significantly over the course of a year; at particular times of the year, such as during lambing or the spring growth period, disruption of farming operations can be devastating to profitability\(^9\). However, irrigation was not necessary at the time of the event and therefore the effect was potentially lessened.

Dairy farms were able to mitigate the impact of electricity disruption with the use of a generator, though few farms had generators available. Dairy farms that suffered catastrophic structural damage to their milking shed used the facilities of neighbouring farms, often without prior arrangement or compensation. Livestock are not especially vulnerable to strong ground shaking, however cows may be injured during ground shaking if they are being milked or are standing on concrete pads.
In general, farms in areas that experienced higher intensity shaking based on the Modified Mercalli Intensity Scale (which is a subjective assessment) were more likely to be affected. Furthermore, the degree to which the farm was affected was loosely correlated to the strength of the shaking.

3 Greatest Challenge
As shown in Figure 3, the greatest operational challenges most frequently cited by farmers after the earthquake were stress, wet ground conditions (relating to earthquake induced changes to the water table), and physical damages sustained on-farm. Stress was commonly associated with sleep deprivation compounding the challenges of managing day-to-day activities. Irrigation concerns were also raised as a significant issue, commonly regarding the increased turbidity of well water. For dairy farmers, stress levels were often identified with concerns around livestock welfare and the ability to milk livestock in the face of electrical disruptions. Livestock management was also of concern as many fence lines were damaged and farmers found difficulty accessing damaged areas due to the wet conditions.

Figure 3 - Word cloud illustration of the greatest challenges as reported by affected farming organisations.

Interestingly, the psychosocial trauma sustained by the event was of equal if not greater significance to the farmers’ ability to maintain operations, than were the physical impacts incurred on-farm. Some of the self-reported psychosocial products of stress were:

1. sleep deprivation;
2. noticed decreased mental acuity; and
3. feelings of uncertainty.

Sleep deprivation was a common issue for many Canterbury residents in the aftermath of the earthquakes, with ongoing frequent aftershocks disrupting sleep. The earthquake and subsequent aftershocks were also the cited cause for decreased mental acuity, which was described as an inability to focus. Similar results were observed in a clinical study, which concluded that the earthquakes led to an increase in the likelihood of errors of omission\textsuperscript{10}. Feelings of uncertainty were commonly associated with managing earthquake impacts, such as un-milked cows and potential damage to irrigation infrastructure. Overall, sleep deprivation and feelings of uncertainty were the most commonly cited products of stress.
4 Mitigating Factors

The three most commonly cited factors by responding farm organisations in mitigating the effects of the earthquake were:

1. well designed and well-built buildings (76%);
2. relationships with their neighbours (71%); and
3. insurance (71%).

The use of neighbours as an effective means to mitigate the effects of the earthquake was found to be unique to farming organisations. Comparatively, rural non-farming organisations cite their relationship with banks or lenders (72%), relationship with suppliers (68%), and the availability of spare resources (56%) as mitigating factors. “Relationships with neighbours” was only cited by 17% of rural non-farming organisations.

Neighbour relationships were used for both psychosocial support purposes as well as for organisational purposes. As shown in Figure 4, the use of these relationships was found to be most helpful amongst farms that were either most affected, or in the areas that experienced the strongest shaking intensities. Examples of farmers’ use of neighbour relations include the sharing of organisational resources, such as dairy sheds, or simply speaking with one another. These results are illustrative of the importance of social networks in rural farming communities.

Figure 4 - Illustration of the relationship between total organisational disruption, MMI and the use of neighbours to mitigate the effects of the earthquake. The likelihood of the farming organisation to find the relationship with their neighbour helpful in mitigating the effects of the earthquake is shown using the grayscale gradient.
5 Conclusions

From the results, three major conclusions stand out. The first is that farming organisations reported being most vulnerable to disruptions in electricity and water supplies. However, no single farming sector was found to be more disrupted than any other by the Darfield earthquake.

Secondly, farming organisations are very reliant on their informal network as a means to mitigate the effects of an earthquake. Neighbour relationships were used to decrease earthquake-related stress, even when the organisation was not very affected. Comparatively, rural non-farming organisations found their relationships with their banks, lenders and suppliers more helpful in mitigating the effects of the earthquake.

Lastly, stress was most commonly cited as the greatest challenge for the organisation in the aftermath of the earthquake. The importance of the farmer’s psychosocial health is likely to be the most critical vulnerability for farming organisations, and there is value in providing psychosocial support to rural communities in the event of an earthquake.

6 References


