"Achieving Outcomes by Building Capability"

The AgriBusiness Group™

Canterbury Farmers' and Rural Professionals' Perception of Drone Use in Environmental Management

Our Land and Water National Science Challenge Rural Professionals' Fund

Prepared for Our land and Water

Prepared by The AgriBusiness Group

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OUR LAND AND WATER — Toitū te Whenua, Toiora te Wai — National SCIENCE Challenges

LINCOLN UNIVERSITY
TE WHARE WĀNAKA O AORAKI

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Executive Summary

The purpose of this research project is to identify barriers to, and incentives to overcome the challenges of, integrating drone use to achieve better environmental compliance outcomes.

Ongoing requirements for environmental improvements by the farming sector and the advancement of unmanned aerial vehicles (UAVs) or drones have led to the possibility of incorporating drone use for environmental management and compliance purposes. Such practices, however, were relatively novel, until COVID-19 alert level restrictions in New Zealand accelerated the adoption of this in selected rural professionals Farm Environment Plan (FEP) audit processes.

With limited knowledge about the pros and cons of drone use in environmental management and compliance processes, this research project set out to investigate the perceptions of farmers and rural professionals about using drones for environmental compliance purposes, and how drone use can be proactively integrated into on-farm management for better environmental outcomes. The project also aimed to identify barriers to the use of drones in environmental compliance, monitoring and management, as well as incentives to overcome these barriers.

Being exploratory in nature, this research project adopted an inductive-led, theory-building approach, incorporated with theoretical and selective sampling of the informants. Observations of the FEP audit processes involving drone use, along with follow-up in-depth interviews of farmers and rural professionals provided the findings of this initial investigation. These findings were further enriched by additional interviews with selected rural professionals who were aware of drone but had not adopted them into their audit processes.

Research results were analysed in light of existing relevant literature to reveal that drones use does have its limit in terms of its subjectivity to weather conditions, and its inability to detect sound and smell. However, drones can be very useful for environmental management and compliance purposes, aided by their ability to save time, access hard-to-get-to places by vehicle or on-foot, provide additional aerial view evidence, and reduce health and safety risks. In particular, drones can be useful during the phase of FEP preparation, as they provide a good overview of the whole farm system. If also used in subsequent FEP audits, then images from the same bird's eye perspective can provide powerful evidence of on-farm improvements in relation to environmental management. This could improve the transparency of the compliance processes.

The benefits, barriers and incentives for the use of drones in wider environmental management that were discovered during this research are shown in Table 2

Table 1: Benefits barriers and incentives for the use of drones.

Benefits	Barriers	Incentives
Time and cost saving.	Trusting farmer-auditor relationship.	Building a strong positive farmer / rural professional relationship
Aerial view providing additional evidence	the ownership and usage of the aerial footage.	Offering to use a drone in subsequent visits after the first visit
Health and Safety	Flying conditions for the drone	Clear and publicised rules/guidelines around drone use in audits and ownership of the footage
	The possibility of drone images adversely portraying the degree of the environmental problems identified	Providing clarity to farmers that the rules/guidelines around drone use will be followed
	The inability of drones to pick up sounds and smells	Creating a wider understanding of the advantages and limitations of drone use in environmental management

The following outputs have been achieved from this research project:

- The text of an article to be included in the next Journal of the NZIPIM has been agreed and submitted.
- The manuscript for submission to a peer reviewed academic journal is being completed prior to submission.
- A conference presentation on the topic has been delivered to the New Zealand Agricultural and Resource Economics Society conference in September 2021.
- A brief summary video has been completed and it is available on The AgriBusiness Groups website along with photos relevant to the subject.
- The video has been promoted on The AgriBusiness Groups website and face book page.
- Dissemination of the research findings to the wider farming community is currently being carried out by the farmer member of the team including being interviewed for “Sarahs Country” broadcast and widely distributing the video.

1 Introduction

1.1 The context of this research.

Monitoring and control (as part of NZ Conformance System or part of Environmental Social Governance (ESG) reporting is essential for practically all NZ industry sectors. In 2016, for instance, conformity assessment facilitated over 60% of NZ exports at a value of 27.6 billion NZD [1] . ESG reporting is similarly important for enhancing value of products for exports as well as for protecting the NZ environment. Robust monitoring and control is also essential for consumer safety and society well-being.

The fast-paced global economy and similarly rapid technological innovation puts the monitoring and control services and infrastructure under increased pressure to keep up with the speed of technological innovation. The *2018 Conformance Policy and Infrastructure Review* stresses that "*MBIE, government agencies and the conformance sector need to remain vigilant and keep up to data with change*" with "*increasing digitalisation and automation probably creating challenges for the current manual conformity assessment techniques*"[2]. The *"manual techniques*" and traditional approaches (such as on-site visits and inspections) that are common in the sector were also exposed during the COVID-19 pandemic, when the sector had to dive deep into contingency plans to introduce ICT to conduct remote audits and assessments[3],[4].

There are a number of efforts underway nationally attempting to integrate new technologies into monitoring and reporting activities. Apart from the *2018 Conformance System Strategy* transformation agenda, various industry sectors (i.e.; Agritech in New Zealand: Industry Transformation Plan, Strategy for New Zealand Food Safety) and many Māori institutions and businesses are also leading the development of ESG reporting systems through the adoption of state-of-the-art technologies. Large investments also went into projects that use technologies to enhance competitiveness of NZ enterprises (i.e.; remote sensing to monitor water quality and use) yet such technological advancements have not translated into a systematic national approach of using such advancements for monitoring and control for the benefit of NZ public and to increase the competitiveness of NZ economy.

In relation to the New Zealand primary sector – there a range of strategies and policies that reflect an increased demand for the monitoring and management of the environmental impacts from farming including:

- MPI *Fit for a Better World*[5] - the vision and strategic direction of this plan calls for more robust monitoring and reporting systems to meet societal and market expectations.
- The MPI/MFE proposed *Fresh Water Farm Plan Regulations*[6] - looks to require farmers to have a comprehensive Farm Environmental Plan with associated certification and auditing of these.
- He Waka Eke Noa - Primary sector climate action partnership[7].

The development of technological solutions such as the use of drones to assist with monitoring and compliance with requirements for biodiversity, water management or carbon management have the

[1] NZIER *Examining the way IANZ supports the New Zealand economy*; New Zealand Institute of Economic Research 2017.
[2] MBIE, Conformity Policy and Infrastructure Review. In Ministry for Business, Innovation and Employment: Wellington, 2018.
[3] Koch, C. M. M., M.; Blind, K. and Castka, P. *Impact of the COVID-19 Pandemic on Conformity Assessment and Conformity Assessment Bodies in New Zealand.* ; A report by Bundesanstalt für Materialforschung und -prüfung (BAM), Germany; TU Berlin, Germany and University of Canterbury, New Zealand.: 2021.
[4] Castka, P. Z., X.; Bremer, P.; Mirosa, M. and Wood, L. *Remote auditing and assessment – learnings from the COVID-19 pandemic and guidance for the future.*; A report for New Zealand China Food Protection Network.: Welligton., 2021-under review.
[5] https://fitforabetterworld.org.nz
[6] https://consult.environment.govt.nz/freshwater/freshwater-farm-plan-regulations/
[7] https://hewakaekenoa.nz

potential to create a number of benefits for the implementation of these policies and providing assurance that negative environmental impacts are being effectively managed and minimised.

1.2 What we set out to research.

The purpose of this research project is to identify barriers to, and incentives to overcome the challenges of, integrating drone use to achieve better environmental compliance outcomes.

This report is an overview report of the research into the topic that was carried out by:

Challenge party- Lincoln University – Dr Sharon Lucock and Dr Victoria Westbrooke.

Rural Professional – The AgriBusiness Group – Sam Mander.

Farmer – David Stevenson.

1.2.1 The scope of the research.

The NZ primary sector is under intensifying pressure to demonstrate ecological sustainability. Driven by this ever-growing pressure, environmental compliance has become an integral part of farming operations in NZ. Meanwhile, technological advances have led to increased use of unmanned aerial vehicles, or drones, for multiple roles in agriculture, from mustering stock to mapping and recording images/videos for product marketing. Can drones also be used to efficiently demonstrate environmental compliance and thus ecological sustainability?

The applicants have trialed using a drone to assist Farm Environment Plan (FEP) audit processes. Farmers have appreciated the greater visibility of potential environmental problems compared to viewing from the ground, as well as decreased time required for the audit process. This research has investigated the perceptions of farmers and rural professionals about using drones for environmental compliance purposes, and how drones use can be proactively integrated into on-farm management for better environmental outcomes. We have identified barriers to the use of drones in environmental compliance, monitoring and management, as well as incentives to overcome these barriers.

1.2.2 Outputs of the research.

The success of this Project will see a more effective integration of drone use into environmental monitoring and management on farm in ways that suit individual farm systems. The outcomes of this are varied, including but not limited to:

- a more efficient and cost -effective environmental compliance process;
- a more effective FEP audit process, leading to improved environmental compliance practices, hence increased protection for waterways and increased environmental health on New Zealand farms;
- greater integration with mahinga kai values on farms, particularly those on iwi land.

The target audience of this Project are all stakeholders who are interested in achieving a more effective outcome from environmental compliance on New Zealand farms. These include farmers, regional councils, rural professionals, marketers and final consumers. The ultimate achievement from this research will not only be improved environments on farms, but also greater ecological balances on farms, and improved social license for our primary sector in the eyes of consumers.

The findings from this Project will be communicated via the following avenues:

- A quality -assured journal article in The Journal of NZIPIM.
- A peer-reviewed journal article in an academic journal.
- A conference presentation at NZIPIM National Conference 2021.
- Video and photo footages that can be used by primary industry bodies and rural media to promote adoption of this new technology.
- Dissemination of research findings in the wider farming community via the networks of the farmer/entrepreneur member in the Project team.

1.3 Our methodology.

Following the inductive-led, theory-building methodological approach, and in light of the choice of investigation via the lens of FEP audit process, this exploratory study employed a mixed-methods approach, involving literature review, field observations and semi-structured in-depth interviews with farmers and rural professionals involved in the audit process.

1.3.1 Literature Review

The preliminary literature review at the conception of this research project revealed that very little scholarly endeavours had looked into the interface between the use of drones or UAVs and environmental management, particularly in relation to compliance processes. Existing literature mostly focuses on smart farming with the aids of drones. The 'greenfield' nature of this research area, where aerial technology interface with environmental compliance, therefore warrant an inductive-led, theory-building methodological approach. As Eisenhardt[8] (1989, pp. 548-549) points out, "given the strengths of this theory-building approach and its independence from prior literature or past empirical observation, it is particularly well-suited to new research areas or research areas for which existing theory seems inadequate", because "they excel in situations for which there is limited theory and on problems without clear answers" (Eisenhardt[9] et al., 2016, p. 1113).

A literature review is often conducted at the start of the research for the purpose of identifying knowledge gaps and hence directing the formation of research questions. However, the literature review in this research project was conducted as part of the result analysis, where the review of the literature is directed by our research findings. In other words, themes emerged from our result analysis became the key words in our literature search. The outcome of this literature review in conjunction with result analysis then become the basis on which the theory-building was conducted.

1.3.2 Field observations and interviews.

Environmental compliance involves multiple levels of legislation, regulation and implementation. However, at the farm level, these are often translated to various aspects of a Farm Environment Plan (FEP). Given the central role that FEPs and their subsequent audits play within the

[8] Eisenhardt, K. M. (1989). Building theories from case study research. *The Academy of Management Review*, *14*(4), 532-550.
[9] Eisenhardt, K. M., Graebner, M. E., & Sonenshein, S. (2016). Grand challenges and inductive methods: Rigor without rigor mortis. *Academy of Management Journal*, *59*(4), 1113-1123.

environmental compliance processes, this research has strategically focused on the FEP audit process, on the following grounds.

The anecdotal evidence that suggested the potential advantages of drone use for environmental compliance started with the drone use for FEP audits, out of improvisation of some rural professionals during the COVID-19 Alert Level 2 pandemic, where auditors had to keep working but maintain social distancing.

FEP audits provide an ideal platform for researchers to observe both the farmer and the rural professional at the same time, to take note on their interactions, both before and after the drone was included as the part of the audit process.

Subsequent interviews after the observation of the audit processes were designed to expand beyond the audit itself. Farmers, in particular, were probed to share their views on the potential barriers and benefits of drone use for monitoring and management on farm for environmental purposes, beyond just what was revealed to them during the audit process.

Our field observations and semi-structured interviews were conducted with farmers and auditors approached following the principles of selective sampling and theoretical sampling (Draucker[10] et al., 2007). This is for the purpose of obtaining rich data from a variety of farm systems that are commonly seen in Canterbury. Farmers were approached using existing networks and client base of the rural professional involved in this project. Their willingness to participate in the project was the only criterion required for informant recruitment.

The farm systems investigated in this research included dairy, arable, sheep/beef, and extensive high country. Field observations were conducted on-farm during FEP audits when a drone was used to visualise the farm. Researchers observed the audit process and farmers' and rural professionals' reactions to the process. After the audit, semi-structured interviews with farmers and rural professionals were conducted, focusing on their views of the strengths/benefits and weakness/disadvantages of using drones within the audit process, and how this could be integrated into on-farm management practices. The rural professional was interviewed after returning from the audit visit.

Specific questions that this research project sought to answer were:

1. What is the current process of using drones to assist FEP audits in Canterbury?
2. What are Canterbury farmers' and rural professionals' perceptions of using drones to facilitate environmental compliance, including monitoring and management on farm for environmental purposes, and what are their thoughts on how this might enable more efficient and effective on-farm management for better environmental outcomes?
3. How can rural professionals utilise drones to improve the environmental compliance services provided to farmers?

In total eight farmers and six rural professionals were observed and interviewed for the project.

[10] Draucker, C. B., Martsolf, D. S., Ross, R., & Rusk, T. B. (2007). Theoretical Sampling and Category Development in Grounded Theory. *17*(8), 1137-1148.

2 Results

This section of the overview report highlights the key findings from this investigation. These findings are a summary of the more detailed research report that has been provided by the challenge party and researchers in this project, Lincoln University. This research report can be downloaded from The AgriBusiness Groups website.

2.1 Use of Drones in the FEP Audit Process

This section describes the audit process, and in particular when drones are used and how they can contribute to the process. The researchers found that the audit process was able to be described in two ways the physical and the cognitive.

2.1.1 The physical audit process.

The researchers found that the physical audit process consists of six stages as shown in **Figure 1**.

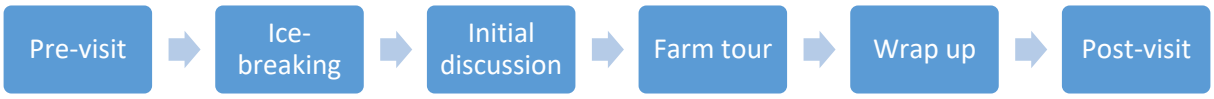

Figure 1 Stages in the physical audit process

2.1.2 The cognitive audit process.

The researchers found that the cognitive audit process consists of five stages as shown in **Figure 2**.

Figure 2 Stages in the cognitive process in auditing

2.1.3 Summary of the FEP audit process.

The conditions in which a drone can be used and the advantages of drone use in FEP audit process, and also the interactions between different factors influencing the benefits of drone use are shown in **Figure 3**.

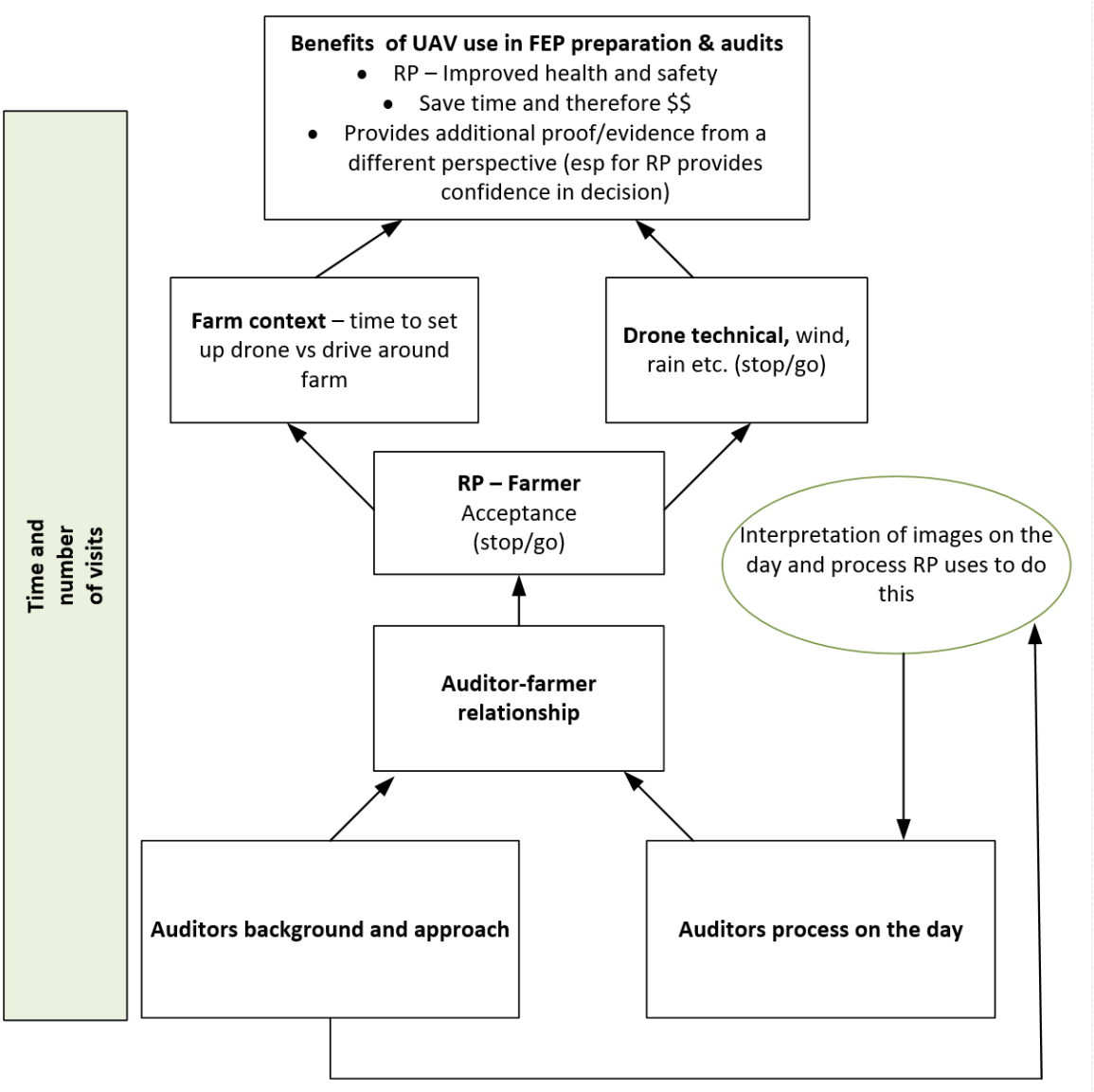

Figure 3 Conditions and advantages of drone use in FEP audit process

Having reviewed the physical and cognitive processes of FEP audits using drones, the following sections report the insights from the interviews with both farmers and rural professionals regarding the benefits, barriers and incentives to use drones for the wider environmental management purposes.

2.2 Benefits, Barriers and Incentives to drone use for wider environmental management.

A summary of the Benefits, Barriers and Incentives that were found during the research into drone use for wider environmental management can be seen in Table 2.

Table 2: Benefits barriers and incentives for the use of drones.

Benefits	Barriers	Incentives
Time and cost saving.	Trusting farmer-auditor relationship.	Building a strong positive farmer / rural professional relationship
Aerial view providing additional evidence	the ownership and usage of the aerial footage.	Offering to use a drone in subsequent visits after the first visit
Health and Safety	Flying conditions for the drone	Clear and publicised rules/guidelines around drone use in audits and ownership of the footage
	The possibility of drone images adversely portraying the degree of the environmental problems identified	Providing clarity to farmers that the rules/guidelines around drone use will be followed
	The inability of drones to pick up sounds and smells	Creating a wider understanding of the advantages and limitations of drone use in environmental management

2.3 Conclusions

Drawing on the results summarised above, this research project has reached the following conclusions:

- Drones can reduce the time taken to conduct an FEP audit, and hence costs.
- Drone use can reduce health and safety risks, especially for inspection of hard-to-get places on farm (by vehicles).
- Drones can also improve the transparency of the FEP audit process by providing additional evidence. But the additional evidence still needs to be backed-up by the farmer and auditor visiting the actual sites on farm and having a discussion, particularly when the evidence is to reveal an environmental problem.
- FEP audits were considered by rural professionals as a tool to bring about behavioral change in farmers towards better environmental practices. This was considered particularly the case on the first audit visit. Subsequent audit visits can, however, become more of a box-ticking exercise, if farmers were already adopting Good Management Practices (GMPs).
- Drones can be particularly useful during the phase of FEP preparation, as they provide a good overview of the whole farm system. If also used in subsequent FEP audits, then images from the same bird's eye perspective can provide powerful evidence of on-farm improvements in relation to environmental management.
- However, a strong positive professional relationship, including high levels of confidence and trust between farmer and auditor is necessary for achieving environmental outcomes through compliance.
- In other words, drones can only enhance environmental compliance provided the critical level of trust and confidence that farmers and auditors have for each other exist, indicating that the farmer-auditor relationship is fundamental for the FEP audit process. Without such trust, there will be a lack of rapport between farmers and auditors, which consequently prevent the positive influence for behavioral change that FEP audits set to achieve.

- There are also certain technical conditions, such as weather and farm topography and scale that are more suited to use drones in FEP audits.
- Drone use cannot provide information to certain senses, such as sounds (e.g. leaky pipe) and smells (e.g. effluent pond) that on-site visits can pick up.
- In order to fully utilise the advantages that drones can offer to environmental management and compliance processes, clarities around the data (particularly drone images) usage and ownership is needed, as this will foster stronger institutional-based trust by the farmers.

3 Outputs

The following outputs have been achieved from this research project:

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