Control or Losing Control: Consumer Perceptions of Controlled Environment Agriculture (CEA) Based on Focus Group Findings

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Abstract: Technology and innovation are important in mitigating the risks imposed by climate change in many areas, including agriculture and food production. Many novel and emerging agri-food technologies are marching their way to market; however, consumer perceptions are crucial to the adoption of new agri-food technologies which claim to be more sustainable than conventional growing systems. This study investigates how the sense of control, an important psychological factor for human behaviours, may interact with consumers’ perceptions of new agri-food technologies, and consequently affect their attitudes towards new technologies for future food production and consumption in the age of climate change. In total, 23 focus groups (n = 117) were conducted across New Zealand using Controlled Environment Agriculture (CEA, a technology-based approach to food production that optimises growing conditions for plants through the regulation of environmental factors) as the exemplar technology for discussion. Findings reveal that, when climate change and the challenge of feeding the world sustainably were presented, CEA was accepted as a means to retain control over climate and environmental crises. Meanwhile, CEA was also speculated as a threat to consumers’ sense of control concerning individual body and health, social order, and ecosystem order. To manage the disruptions that CEA may impose on perceived control, consumers may adopt different strategies to compensate for the perceived loss in their sense of control.

Keywords: sense of control; new agri-food technologies; controlled environment agriculture; control-enhancing; control-threatening; compensatory control

1. Introduction

Social psychology has long established that individuals in general have an innate motivation to be in control of their environment and the outcomes [1,2]. By gaining control, individuals fulfill the basic need to perceive the environment as stable and safe, as well as preventing feelings of randomness and chaos in the world [3]. However, individuals’ desire to control their outside environment and the outcomes is not always satisfied in reality. One area that requires a strong sense of control yet constantly faces various challenges and disruptions is agriculture and food production, which is essential to human survival. Challenges such as environmental degradation, climate change, and the need to feed the world’s population of 10 billion by 2050 are threatening conventional agricultural systems’ ability to secure adequate food supply in a sustainable manner [4]. New and emerging agri-food technologies such as Controlled Environment Agriculture (CEA) are proposed as potential solutions to these challenges and fulfill the Sustainable Development Goals, including zero hunger and nutrition equity [5–9].

CEA is not a completely novel concept to agriculture. The term was first introduced in the 1960s, referring to an intensive approach for controlling plant growth and development by capitalising on advanced horticultural technologies [10]. Along this pathway in the recent decade, CEA has evolved into advanced forms such as indoor vertical farms [7,11]. Indoor vertical farms feature a high-tech form of CEA where, typically, plants are grown...
inside a building and stacked across multiple levels; LED lights, temperature, humidity, and water and nutrient supply are accurately controlled to maintain an optimised growing condition for maximum yields through all-year-round production cycles [5,7]. Given all these features, CEA is claimed to greatly increase efficiency (faster), boost yield (more and all-year-round), improve product quality (freshness, taste, nutrition, etc.), and enhance resilience and adaptation to climate change [5,8,12–15]. It is also argued that CEA is specifically suitable for places that are most at risk of climate change anomalies, and areas that are densely populated [9,16].

Existing literature reveals that a sense of control is a fundamental human need that influences various aspects of consumer behaviour [17–19]. Specifically, Compensatory Control Theory (CCT) suggests that individuals are motivated to restore a sense of control when they perceive it to be threatened or diminished [3,20]. Whilst the name of CEA may signal a sense of ‘control-enhancing’ by offering advanced control of the growing environment, no research has investigated how consumers’ sense of control may respond to CEA. Furthermore, new technologies like CEA are usually systems of sophisticated and complicated features, thus they may stimulate complex consumer feelings and responses simultaneously, contributing to various attitudes towards CEA [21–26]. Therefore, more research is needed to capture the nuances between consumers’ sense of control and features of new technologies in order to address consumer concerns and promote public acceptance.

Using CEA as an exemplar technology, this research adopts the theoretical lens of control, in particular the Compensatory Control Theory [20,27], to explore the interactions between consumers’ sense of control and their perceptions and attitudes towards new agri-food technologies. CEA is considered a suitable context for this study because it is a relatively new yet rapidly developing field and is in the early stages of commercial application in society, making it not too challenging for consumers to understand its features.

We propose that consumers’ sense of control will be affected in various ways when different features of a new agri-food technology are presented. The change in their sense of control, either being enhanced or decreased, will further affect their perceptions and attitudes towards this new technology. Specifically, we seek answers to the following research questions:

1. How does consumers’ sense of control interplay with CEA?
2. What are the compensatory control strategies if the sense of control is threatened or lowered?

Our work contributes to the literature on new technology acceptance and consumer behaviour by revealing that new agri-food technologies can be perceived as both control-enhancing and control-threatening at the same time, and different compensatory control strategies will be employed in situations where the new technology is considered as a threat to the sense of control. Practical implications based on the findings are discussed at the end of the article.

2. Theoretical Background

2.1. Sense of Control and Need for Order—A Fundamental Motivation

Control refers to the ability to influence outcomes in one’s environment [28]. Personal control specifically refers to “a person’s belief that he or she is capable of obtaining desired outcomes, avoiding undesired outcomes, and achieving goals” [27]. Prior research suggested that individuals have a fundamental need to see themselves as competent by securing control over their environment [3]. A sense of personal control allows individuals to psychologically defend against the anxiety associated with thinking that their environment is random or unpredictable [29]. Therefore, personal control is not only considered to be a fundamental human motivation [20,27,30,31], but also associated with several indicators of well-being, e.g., health and happiness [32,33].

As a fundamental psychological factor, the sense of control can be viewed as both dispositional and situational [1,3,34,35]. One the one hand, as a dispositional personal
trait, individuals differ in the amount of control they generally desire to possess over the environment [36,37]. One the other hand, when the surrounding environment or external circumstances change, people’s sense of control, or perceived control, can also fluctuate according to the changing situations [3,34]. Furthermore, situations causing reduced control are not desirable yet very commonplace. People are regularly faced with unpredictable situations in life, from natural disasters to man-made errors, that can threaten and reduce their sense of control over the environment and the outcomes.

2.2. Compensatory Control—Pathways to Restore the Sense of Control

Given the importance of the sense of control, Compensatory Control Theory (CCT) posits that individuals will be motivated to seek the restoration of control in situations and circumstances when perceived control is threatened or lowered [3,20]. Previous work on CCT demonstrates that individuals’ sense of control can be regained by strengthening their belief that they have the ability to affect outcomes in their environments or that they have access to an external agent who possesses such ability [1-3,27]. Furthermore, prior studies point out that domains of control deprivation and control restoration do not have to be related [3,30,38]. That is, the sense of control gained in one domain may spill over to another, or, in other words, control gained in one domain may compensate for the loss of the sense of control in another, so that the fundamental desire for control is still satisfied.

The existent literature has documented a range of sources of compensatory control. For example, one may develop illusory beliefs about one’s influence over random events, belief in an interventionist God, be supportive of governmental control and hierarchical institutions, and belief in scientific processes [2,3,20,30,38,39]. CCT further argues that a situation in which an individual lacks personal control is considered aversive first and foremost because it undermines fundamental epistemic beliefs in the non-randomness of the world [3,27,40]. This implies that the primary psychological motive to restore control is not retaining control per se, but the need to perceive the world as orderly, structured, and predictable [20,27]. Thus, CCT sees direct personal control and various forms of “compensatory” control as functionally equivalent and therefore ultimately substitutable, since they all serve the purpose of achieving a sense of control which defends the feelings of the world being random and chaotic [20,27]. This also explains why control deprivation in one domain could be compensated by the sense of control in another. Afterall, it is the perceived ability to control that matters.

2.3. Sense of Control and Consumer Behaviours

The sense of control has been found to be influential to individuals’ purchase decisions and intentions. Studies showed that consumers with a high need for control preferred products associated with positive outcomes, i.e., “lucky” products, because these “lucky” products gave them an illusion of control [17]; when perceived control is threatened, consumers prefer utilitarian goods that promote a sense of control through problem-solving qualities [18] and prefer brand leaders that can offer a symbolic sense of personal agency [19]. More specifically, with new technologies and new products, Rutjens and colleagues revealed that, when experiencing a lack of control, consumers demonstrated a preference for high-tech solutions to address environmental challenges, because beliefs in science and progress help to ensure a perceived order of the external world [38,41]. These studies suggest that, when perceived control as an important psychological status is lower than desired, products and consumption behaviours could serve as a way to boost the levels of consumers’ sense of control. In this sense, consumption is positioned as a means of control compensation for consumers.

Some other studies investigated how product characteristics and consumption experiences may result in a lowered sense of control, and thus discouraging consumption intention. For example, a study by Faraji-Rad, Melumad, and Johar [35] pointed out that consuming new products may cause a sense of losing control for consumers who desire a higher level of control, and the authors suggested that some characteristics of a product
may threaten the sense of control whilst other characteristics of the same product may increase the sense of control at the same time. Shepherd and Kay [42] further demonstrated that the same product/item can be perceived as control-enhancing and control-threatening, respectively, by different consumer groups. Their study found that guns were perceived as a source of control for conservative consumers whilst, at the same time, a threat to control for liberal consumers, thus resulting in divided opinions on guns between liberal and conservative consumers. When it comes to new food technologies, for example, genetically modified (GM) food, Yang et al. [43] showed that consumers were more inclined to reject GM food when experiencing a lowered sense of control, despite the potential benefits that GM food can offer to crop cultivation. In this case, GM food production itself represents a significant source of risks and uncertainties for consumers with a lower sense of control, which may result in the need for extra compensatory control from other sources. These findings indicate more nuanced interactions exist between consumers’ sense of control and the target product/experience for consumption. So far, little work has specifically investigated these interactions; thus, further work is necessary to unpack these nuances.

3. Materials and Methods

This study adopted an interpretivist paradigm by using the qualitative method of focus groups with consumers. Interpretivist paradigms work with the aim of describing a phenomenon as the lived experiences participants hold, and from this experience, to build conceptual theory [44]. This research utilises knowledge of how consumers hold values and emotions as subjective to their own constructions [45], and it is through this lens that the focus group was used to capture how participants responded to CEA from their personal perspectives. In the group discussion, participants engaged in talking about their real and imagined lived experience with CEA, resulting in the collection of rich descriptions that unveiled their constructions of responses to the technology [46].

3.1. Participant Recruitment

Participants were recruited from the general public who were aged 18 years old and above, self-reported as actively engaged in their household grocery decision-making process, and were regular consumers of fruits and vegetables. It is argued that acceptance of new technologies is more likely in younger groups than in older groups [47], thus participants were recruited into either a younger group (20–40 years old) or an older group (41–60 years old) according to their age. It is also believed that consumers’ understandings of and relationships with foods should be understood within their social and cultural context [48], so we also recruited participants into horticultural groups and metropolitan groups according to where they lived, so that both urban and rural perspectives could be captured based on participants’ proximity to horticulture practices. Furthermore, we specifically recruited consumers who self-identified themselves as Māori ethnicity (the indigenous people in New Zealand) to represent the indigenous culture in New Zealand. Māori participants accounted for 21% (n = 24) of the overall sample size. Overall, they represented a spread of income, age, gender, ethnicity, and occupations.

3.2. Data Collection and Analysis

A total of 23 focus groups (n = 117 participants, 4–6 in each group) were conducted via the online conference platform Zoom in both rural and urban New Zealand in November and December 2021. A semi-structured interview guide was developed for the focus groups based on previous research and a literature review, and visual aids were used through the shared screen function of Zoom during the focus groups to illustrate the basic features of CEA. To not bias the participants, no further information of the advantages and/or disadvantages of CEA was given by the moderators.

For each focus group, two researchers were present, with one acting as the primary moderator and the other as the co-moderator and observer. This was to ensure the quality of the moderation and prevent technical problems if one researcher experienced network
issues during the group discussion. These focus groups lasted about 90 min, were recorded, and then transcribed into transcripts for the analysis. Thematic analysis was undertaken following the qualitative data analytic procedures suggested by Spiggle [49], with an iterative, data-driven approach. Open coding and then axial coding were performed to identify the major themes from the transcripts following an iterative back-and-forth process [50]. NVivo 12 as a qualitative analysis tool was used to facilitate the analysis.

4. Findings

Three major themes were identified of interest to the research questions concerning the interplay between consumers’ sense of control and CEA, and the potential compensatory control strategies. In order to best convey the context and nuances, these themes are presented in this session in a narrative approach [51–53], accompanied with illustrative quotes from participants with pseudonyms and basic demographic information, i.e., gender and age at the time of data collection. As all focus group data were thematically analysed in entirety, these illustrative quotes should be understood within the context of the themes rather than isolated participant accounts [51,52].

4.1. CEA as a Means to Retain Sense of Control

Firstly, participants recognised there is a need for the sense of control with food: “we worry about not being able to have control over our food supply” (Steve, male, aged 30). Compared to outdoor farming and even greenhouse farming, which is largely subject to external natural conditions, CEA presents a form of protected indoor farming in which growing conditions are finely controlled by humans. Among the participants, these features led to a sense of enhanced control of farming processes and outcomes via CEA, including product quality, nutritional value, yields, etc. For example, participants commented the following:

If you can control the growing, you can maximise the nutrients and you can make them even healthier. (Levi, male, aged 26)

I grew up on a farm, so I know that that control side of (CEA) is amazing. Because if you know exactly how much sunlight you’re going to get and how much moisture you’re going to get, you’re going to get the perfect tomato, . . . you’re going to get the perfect everything. (Daniel, male, aged 34)

Improvement in the growing processes also makes the prospects of overall production outcomes more positive at a large scale with CEA. For example, one participant expressed the following reasons for supporting CEA:

I’m pretty for indoor farms, I think it’s the effective and efficient way to move forward. I think total control just means a lot more for everyone. You can grow all year round, you can control everything, you’ve got control quality, so consistent, reliable outcomes. (Husdon, male, aged 23)

Furthermore, CEA removes the uncertainty of weather conditions that may negatively affect the growing process, such as droughts, floods, and extremely cold or hot weather, because “it’s not reliant on the weather, so there’s not lots of loss, rain, or hail and things, no waste” (Flora, female, aged 39). Being less dependent on external growing conditions and more controlled by humans, CEA was expected to be capable of preventing losses from adverse weather events and therefore stabilising the food supply. This was highly regarded by participants, especially given the rising awareness of supply disruptions caused by climate change. For example, participants commented the following:

I can see the merit in indoor buildings and the like, as the weather gets more fickle. With global issues and its reliability, you’re almost guaranteed to have a crop (from CEA). (Owen, male, aged 57)
Suppose as weather becomes increasingly more unpredictable, you’re going to safeguard against those wild weather events that just destroy a whole season’s worth of crops. (Ben, male, aged 30)

Again, in the face of disruptive weather events which may destroy crops and subsequently disrupt the food supply, participants perceived that CEA would offer the chance to restore the order of food production and supply, and ensure a positive outcome of food security.

In addition to enhancing control over food production and supply, participants also expressed positive feelings of CEA regarding controlling the environmental impacts of agricultural activities. Many participants were aware of the negative impacts of conventional farming activities on the environment, such as overuse of chemical substances and the large demand for land and water resources. Thus, many of them recognised that CEA offers a new approach for growing produce with a more efficient use of land and water and the minimal use of sprays, having less negative environmental impacts whilst securing maximum outputs. As such, CEA eases the tensions between feeding the world and saving the planet, so that the world can be perceived as less chaotic. For example, Ava (female, aged 40) gave her approval “because you (are) getting maximum productivity to feed a lot more people”, and Tay (gender-neutral, aged 23) also liked CEA because of “the ability to optimise the growing of food as we come to a time where there’s more people everywhere, and less room for these large outdoor farms”. Furthermore, “(CEA) should mitigate waste runoff into the waterways, spray drift from one property to another or just physically into the atmosphere” (Lucas, male, aged 56), and if more foods can be produced locally by CEA, “cutting down transport costs and emissions from ship vessels” (Bella, female, aged 26).

These comments demonstrated participants’ perceptions that CEA could help human society to enhance control over agricultural activities to achieve better results for the food supply and less impact on the environment. Thus, accepting CEA could help individuals to maintain the world as orderly.

4.2. New Technology as a Threat to Sense of Control

Although CEA was perceived by participants as a means to retain human control over food production and supply in general, such control was thought to not benefit individuals and different social groups equitably, as people play different roles in the food chain. When it comes to implementation and adoption, CEA could be seen as a threat to peoples’ sense of control. One of the participants pointed out that “it’s not the practice (of using new technology) itself. It’s more just what people could choose to do with it that’s concerning” (Amelie, female, aged 37); others also worried that consumers would not hold strong control over the way that CEA would be implemented and used in growing practice.

For individual consumers, the most prominent concern is that CEA could potentially undermine personal control over their body and health outcomes due to the unknown impact of long-term consumption of CEA produce. Despite the recognition that CEA may offer produce with enhanced, or even personalised, nutritional value given its capability of controlling the growing processes, many participants expressed their concerns that CEA produce may turn out to be not good for human body in the long run. One of the typical comments on this matter was as follows:

(what about) the long-term health impacts (of CEA produce) and relationships with chronic health conditions or contributing to health conditions, […] do we really know what the impact is over a lifetime? (Lorraine, female, aged 31)

Another participant also commented on concerns of being unable to control for the future outcome of her child’s health:

I’m just a bit worried, kind of thinking from a mum’s point of view, what’s going into my child’s body? And we can tell already by the difference between our bodies nowadays and what they would have been back in the day, foods got to have had a lot to play in that. (Aria, female, aged 39)
The fear of the unknown and the worry about CEA causing devastating health outcomes led to a sense of losing control among many participants. In this sense, avoiding the anxiety caused by feelings of losing control over one’s body and health is a psychological driver for the rejection to engage with CEA and other new technologies alike.

Adopting CEA may also result in a sense of control deprivation in some groups whilst enhancing the sense of control of other groups. In reality, some participants worried that CEA might be held primarily by big growers who can afford to implement this technology, which was supposed to be expensive. Adoption of CEA would enable these growers to not only enhance control over their growing practice, but also gain more control over consumers and other players in the food chain. For example, from a consumers’ point of view, their sense of control might be threatened because they do not hold the technology:

CEA gives the people who are making it total control, but not that I have any control over my tomatoes getting grown anyway. (Seta, female, aged 37)

You’re taking food production out of the hands of a lot of small people and put them into the hands of one large entity, which does worry me. (Levi, male, aged 26)

Concerns were prevalent among participants that CEA could result in disruptions at a broader societal level, such as small growers losing their livelihood and workers losing their jobs when transitioning to CEA from conventional practices. These groups would also experience a sense of losing control in their life when facing the challenges brought by CEA. For example,

if not supported by the government to move to these newer forms of farming, they (small growers) would lose their livelihoods, probably pretty quickly. (Tay, gender-neutral, aged 23)

if using factories and warehouses to grow it, that means they’re gonna become the automated process, so the means less employment. (Logan, male, aged 34)

Finally, there were also concerns that CEA may introduce disruptions to the wider ecosystem. Although typically established as concealed units, CEA will still be part of the ecosystem and will exchange with the external environment constantly during its operation. Similar to the concerns regarding the long-term health effects, the worry was how CEA would impact the overall ecosystem in the long term, and whether there would be any unknown and uncontrollable knock-on consequences:

if we took the complete component of growing things indoors for our own benefit, I wonder what kind of insects and animals and things that the whole ecosystem would rely on may probably die because of that? (Melody, female, aged 24)

Another participant also commented with a holistic approach on the interactions between CEA and the external system:

looking at things holistically, like not just saying this is food that we’re growing in a room, but actually the effects in how that’s actually going to be supplied from outside, and whether it’s going to cause a deficit somewhere else to make this happen. (Sheila, female, aged 56)

Regarding the outcomes of the disruptions that CEA may cause to the ecosystem, “a lot of species of New Zealand that are native to New Zealand that would be really sad to see being lost because of whatever the food industry has done or wants to do” (Emma, female, aged 60). Other comments such as “too far down the track” also indicates a status of lacking order and a sense of losing control of both the environment and the outcomes. These concerns demonstrated how individuals’ sense of control could be threatened by CEA in terms of their personal health, the orders of society, and that of the ecosystem.

4.3. Strategies of Compensatory Control

We identified three compensatory strategies corresponding to the various situations when participants’ sense of control was threatened by CEA, which were (1) bolstering
personal control; (2) relying on external agencies such as structural institutes and scientific processes; (3) claiming faith in the controlling Mother Earth or God.

The first approach was to boost personal control through reclaiming personal agency in individual decision making on food, typically featuring behaviours such as growing your own, buying from trusted traditional produce, and self-education on CEA via information-seeking and validating. By growing their own produce, individuals can maximise control over the growing processes whilst being less dependent on the food chain. For example, Sofia (female, aged 46) insisted that “if that’s how it’s gonna be in the future going forward of supermarkets and fruit markets, then I better start learning how to grow my own vegetables”. Staying with trusted traditional produce can also help maintain their sense of control by not violating the existing order: “I’d probably just stick to what I know, and just go with natural because you can’t go wrong that way” (Suzie, female, aged 21). By self-education on CEA, one can strengthen their understanding and re-establish their perceptions of a world with CEA, so that they can still view themselves as capable of coping with the new environment with CEA and thereby achieve desirable outcomes. Many participants believed that education and transparent information will help consumers to remove their fear of unknown:

people are only scared of the unknown, scared of things they don’t understand. So if there was a lot more education and clarification, if there was information put out about it, and it was more kind of normalised, I feel like people wouldn’t be so afraid of it. (Amanda, female, aged 20)

as long as people are educated about how it’s grown, where it’s come from, they’d be much more open to it. (Flora, female, aged 39)

The second compensation was resorting to external agencies which are capable of maintaining or restoring the order of the surrounding environment, such as governmental and scientific bodies, to exert control on behalf of general consumers. In relation to the potential unknown health and safety impacts of consuming CEA produce, one way to assure participants is to “ensure there are really stringent scientific tests around everything and ethical guidelines and regulations” (Amelie, female, aged 37). With governmental regulations and robust scientific processes overseeing CEA on behalf of the public, consumers can still perceive the world as orderly and desirable outcomes can still be anticipated. For disruptions caused by CEA at a societal level, such as job losses and small growers being outcompeted, a number of participants also expressed that governments should take an active role to ensure a smooth transition to CEA if this is the direction for future agriculture. For example, “there may be needed some government agency, like in many industries, specialised agency, to oversee it” (Mia, female, aged 52). Another participant also stated that all things should be taken into consideration by an overseeing body to safeguard the wider community:

definitely some kind of government oversight or scientific oversight (is needed) as well, just to make sure that we’re doing things with a view of the wider community, and the nature and that sort of thing, all those things are taken into consideration, not just profits money. (Mike, male, aged 40)

The third approach underscores the belief in Mother Nature or an overseeing God as the ultimate source of order and control in contrast to the emphasis on human efforts, either individual or collective, through structured institutes, as seen in the first and second strategies. For participants who held such beliefs, the world operates better on its own rules without too many human interventions, especially when the discussion extended from CEA to other technologies such gene editing (GE). One participant commented that “you can’t mess with what’s been done for hundreds and thousands of years. So, my perception is Mother Nature is always the winner with food and what we put into our body” (Luke, male, aged 35). Too many human interventions enabled by new technologies might disrupt the existing order, leading to chaos and other consequences which could be uncontrollable for human beings. For example, Dylan (male, aged 46) believes that “nature does a better job of deciding what are the best plants to survive or thrive, than the ‘scientists’ would”. Therefore,
human beings are not capable of “playing God” and should not try to “play God”, so that human societies do not end up with “messing up with the nature” or “crashing our own system” by using new technologies. Believing in Mother Nature is likely to result in the rejection of new technologies, and “natural ways” of farming will be more preferred than “technological ways”:

I’d 100% rather eat food that was grown locally, under the sun, in a regenerative farm, for example, knowing that the nutrients were natural, not synthetic, the nutrients were cycled through the natural nutrient cycles that have existed for millions of years, and the subtle nuances that exist in those ecosystems, (which) do make a difference in the quality of the food and the health of the food. (Oliver, male, aged 35)

5. Discussion

It is argued that a sense of control and exercising control over the environment by being able to choose is not only desirable but also a psychological and biological necessity to maintain an individual’s well-being [32]. In the context of food, perceiving a sense of control is particularly vital to human well-being given the fundamental role of food in nurturing our physical and mental health. This study pioneers the exploration of how various features of new agri-food technologies, such as CEA, can impact an individual’s sense of control, either enhancing or threatening, depending on specific areas where orders and control are particularly desired, as well as the corresponding characteristics of the technology. Different compensatory strategies were also discussed when the sense of control was threatened by CEA.

Firstly, CEA is perceived as control-enhancing in securing food supply for the growing global population and making agriculture more resilient to threats from the external environment. While the pressing issues of climate change, environmental degradation, and the need to feed the world imposes perceptions of disorder in life and cause anxieties [54–55], CEA features capabilities that could help handle some of these issues and rebuild an orderly status. For example, CEA demonstrates technical advancements in optimising crop traits, minimising the input of natural resources (e.g., water, land, fertilisers, etc.), and maximising production outputs, via enhanced accuracy, efficiency, and productivity. Accepting such a technology with control-enhancing features is accepting the progress and a new order into life. In other words, CEA can serve as the compensatory control for people who perceive to be lacking control due to the disruption and disorder caused by environmental and climate crises. This aligns with the findings from previous research that sustainability matters to consumers’ acceptance of new food technologies. It also explains why many new and emerging agri-food technologies adopt sustainability narratives and frame themselves as a sustainable solution to the current environmental challenges and food crises [6].

While the control compensatory aspect of CEA is highlighted, the control-threatening features have been seldom addressed in the literature from the lens of the sense of control. Instead, existing research more often explains consumer rejection of new agri-food technologies from the perspective of risk perception and did not explore further from the lens of control perception [56,57]. While risk perception focuses on the judgment of the probability of a negative outcome occurring and the severity of its consequences, control perception emphasises whether one believes they can command the outcome—either obtaining desired outcomes or avoiding undesired outcomes, especially when exposed to risks [2,19,58]. Our study reveals various areas where CEA might be perceived as control-threatening instead of enhancing or compensatory. Personal health outcome is one of the domains where CEA could be perceived as control-threatening. Food plays such an important role in individuals’ health that perceived health risks have long been considered as one of the major barriers for consumer acceptance of new food technologies [59–62]. Despite the potential benefits, e.g., enriched or personalised nutrition, the possibility of unknown long-term effects on health may easily lead consumers onto the feeling of losing control of their own body and health, as the general public tends to focus on the negative side of the possible outcome [60]. In this case, we found that consumers either need to equip themselves to the extent that
they can confidently comprehend and perceive control over the risk of the technology by themselves, or rely on external agencies such as the government or the scientific research process to exert control over and maintain the order of the world for them.

CEA may also cause disruptions to society and ecosystems, so that a sense of control deprivation could be perceived by some consumers and some groups, if not all. Being disruptive in nature, technologies will inevitably violate some of the existing orders related to the traditional farming methods, workforce, working routines, etc., and even expand the knock-on effects to the entire society [63,64]. Such extensive disruptions, if not managed properly, will leave the world feeling disorderly for many in the society. In a similar vein, as a novel element to the broader ecosystem, the long-term impact of CEA on the overall ecosystem is unknown, thus may potentially disrupt the natural order and cause feelings of disorder and the lack of control among those who live in that environment. Previous research has heightened the important role of control in disruptive times in various areas, for example, employment [65], pandemic responses [66], and customer engagement [67].

In the context of new technology adoption, individuals may not be capable of coping with disruptions at the societal level by their own means, thus structured institutions would be needed to fix the disruptions and guarantee a world with adequate order. Alternatively, one may look to spiritual agencies, such as Mother Nature or God, to maintain the rules of how the world should operate; too many human interventions, including the implementation of new technologies, would cause unnecessary disruption to the world. Therefore, instead of seeking human efforts in restoring the sense of control and order, these groups of consumers would prefer to seek “natural solutions” which have as few “technological interventions” involved as possible.

In line with the findings of early studies of compensatory control [3,30,38], our study also identified three compensatory control strategies to cope with the negative impact of CEA on consumers’ sense of control, which are boosting personal control, resorting to external agencies, and believing in Mother Nature. CCT posits that different ways of compensatory control are ultimately substitutable, as they do not aim at exerting control, but the perceived order and perceived capability of control [6]. However, when considering the actual context of acceptance of new agri-food technologies, our study found that these compensatory strategies correspond to different situations where consumers’ sense of control in various areas is threatened or lowered by the introduction of CEA.

These strategies imply consumers’ different attitudes and responses to CEA, indicating potential barriers for them to accept CEA. For example, boosting personal control through growing your own means a rejection to either conventional produce or CEA produce, but self-education may lead to a welcoming attitude if the consumer feels capable of managing the changes caused by accepting CEA into their world, thus the desirable level of control is maintained.

This is also in line with existent literature that information and education on new technologies may improve consumer acceptance of new food technologies [68–70]. And for the majority group of consumers, trust in the technology is still essential for acceptance, either through trusting the government or the scientific research body [71–73]. From the perspective of trust, reliance on structural institutions such as governments and scientific research bodies remains a common strategy to relieve themselves from the anxiety caused by disruptions in the surrounding environment when new technologies are introduced to the society. Their sense of control may be able to maintain as long as such external agencies are trusted and will act on their behalf. Beliefs in Mother Nature, on the other hand, reflect the concerns that new technologies may violate the natural order. There is a fundamental conflict between the “natural rules” and “human efforts” in trying to define how the world should operate according to human needs and wills by using new technologies. As such, new technologies could be perceived as a constant source of threat to consumers’ sense of control which may drive them towards “natural products” and to avoid “technological products”. This may also explain the preference of “naturalness” for food in that “natural food” aligns with natural rules.
6. Contributions, Limitations, and Future Research

Our study contributes to the theory of control and consumer behaviours by revealing the multiple dimensions of how consumers’ sense of control may be affected by the different features of one specific agri-food technology, which is CEA in this context. A rich body of research has exemplified the psychological importance of perceiving oneself to be in control of the environment and outcomes in life [2,20,27,74]. The general motivation for a such desire to retain control is explained as a more fundamental need for order and structure [20,27].

It is also important to understand that people may differ in the extent to which, and in what areas, they particularly desire for order and structure, and consequently require perceived control [37]. The current study explores consumers’ perceptions of a new agri-food technology (CEA) and investigates how different features of that technology are associated with various areas where consumers’ sense of control may change as they imagine future life with that technology. As complicated as a new technology could be, so too is consumers’ psychological reactions in their sense of control correspondingly in multiple areas, as was found in this study. This makes our study among the first to focus on the subjective associations between a new technology and the areas where a sense of control may be affected.

Our study differs from previous studies which have predominantly focused on consumer behaviours and consumption experience as a means of compensatory control to cope with a lowered sense of control or control deprivation, e.g., [17,18,34]. The current study demonstrates how experience with a consumption object, such as a new technology like CEA, can impact one’s sense of control extensively. Our research also reveals that, in the actual context, compensatory control measures are not always substitutional; rather, they may be contradictory to each other, thus consumers’ choice for one compensatory measure may exclude the other. This study represents a good example to explore how consumers would perceive and respond to something that is disruptive in nature, especially in a fundamentally important area of food, with the lens of control.

Our study also brings some valuable insights for the education and promotion of new agri-food technologies in the public. Framing new agri-food technologies as a way to tackle complicated and threatening issues such as climate change and feeding the world is commonly used in practice to gain consumer approval [5,75]. From a control perspective, such framing will assist consumers in perceiving these technologies as control-enhancing, thus may promote acceptance. On the other hand, more attention needs to be paid to the areas where new technologies may threaten consumers’ sense of control, and compensatory strategies may apply accordingly. For example, information and education has been found important for public understanding of new technologies, yet it produces mixed results in terms of promoting consumer acceptance, e.g., [76–78]. Sometimes, such information is too scientific and beyond the comprehension of the public, making individuals feel that they are not capable of understanding, which will then further undermine their sense of control rather than boost their personal control. With regard to perceived health risks and benefits, it is important to ensure governmental agencies and scientific research bodies are consistently monitoring and exerting control in this space. Another possible application is to minimise the perception of the negative impact of new agri-food technologies on natural rules and orders, and show the efforts of monitoring such potential impact; thus, the public can perceive this as being under control, while natural rules are also not violated.

We acknowledge that there are some limitations with this study. As a piece of exploratory work using data collected from purposively recruited focus groups, the findings from this study do not have generalisation power to the general population. Also, only one new agri-food technology was investigated within only one population, and other different technologies and different countries are worthy of exploration in their respective contexts, particularly with technologies that are more controversial, such as gene modification and gene editing. Social and cultural contexts will be also important, as they may impact different areas where the sense of control is more desirable for people living in these contexts.
than those in other contexts. The relations between perceptions of new technologies and the sense of control also need future research to further quantify and test with respect to their influence on consumers’ attitudes and acceptance of new agri-food technologies. More specifically, when the sense of control can be strengthened and threatened at the same time in multiple areas, it is important to explore how the sense of control in these different areas collectively contributes to the overall acceptance of new technologies. The coexistence of both a strengthened and decreased sense of control also mirrors other types of dualities found in literature, such as the citizen–consumer duality in the context of pro-environmental behaviours [79,80]. Exploring how this duality in consumer roles may intersect with the dynamics of control perception in the context of new food technologies could reveal valuable avenues for future research.

Author Contributions: Conceptualisation, D.M.C. and I.C.G.; methodology, D.M.C. and I.C.G.; formal analysis, I.C.G.; data curation, I.C.G. and D.M.C.; writing—original draft preparation, I.C.G.; writing—review and editing, D.M.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Ministry of Business, Innovation, and Employment of New Zealand, grant number P/952001/01.

Institutional Review Board Statement: The study was approved by the Ethics Committee of The New Zealand Institute for Plant and Food Research Limited.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

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