Abstract
Data is essential to governing those emerging matters of concern that confront the agrifood every day. But data is no neutral intermediary. It disrupts, exposes, and creates new social, economic, political, and environmental possibilities, whilst simultaneously hiding, excluding, and foreclosing others. Scholars have become attuned to both the constitutive role of data in creating everyday worlds, and the need to develop critical accounts of the materialities, spatialities and multiplicities of data relationships. Whereas this emerging work develops insight to the capacity for data topologies to reterritorialise the spatial performances of everyday life, it has largely reduced the associated temporal dimensions to matters of fact. The effect of these performances has been to naturalize the temporal quality of speed and elide the multiple temporalities required to enact contemporary data worlds. Applying the lenses of infrastructuring, performativity and ferality, this paper explores temporality and data in the everyday worlds produced through the New Zealand kiwifruit industry’s focus on dry matter. The paper argues that temporalities are deeply embedded in the kiwifruit industry’s data relations. We show that while temporal data relations are critical to the industry, we also highlight ways in which those relations introduce new, potentially destabilizing performances into kiwifruit relations.

Keywords Data · Temporality · Topology · New Zealand · Kiwifruit · Dry matter

Introduction
Scholars have become attuned to the constitutive role of data in creating everyday worlds, and the need to develop critical accounts of the materialities, spatialities and multiplicities of data relationships (Dalton and Thatcher 2014; Pickren 2018). A feature of this emerging work has been a developing understanding of the intricate topologies of data relations and how these topologies reconfigure the spatial performances of everyday life (Allen 2016; Campbell 2019; Hönke and Cuesta-Fernandez 2017). Much of this work has concentrated the constitutive role of data in ostensibly social contexts: for example, in urban settings, through the role of smart cities rhetoric and performance (Mora et al. 2017); and in health studies, through critical examinations of the ‘Quantified Self’ (Lupton 2016, 2019). However, the role of data has also received increasing attention from agrifood scholars as part of a growing focus on the digitalisation of agriculture (for a review see Klerkx et al. 2019). There is a focus on how data is ‘constructed and used’ (Bronson and Knezevic 2016), and the socio-economic consequences that result from the (im)balance of power in agri-food data relations (Rotz et al. 2019). While this research raises important questions regarding (for example) data sovereignty and data justice, there is a tendency to assume data is a predictable intermediary that passes between human agents without transforming the social. This emphasis leaves the role of data as an ‘unpredictable mediator in social relations’ under-explored (Ascui et al. 2018, p. 907). As a notable exception, attending to the ‘lively’ and agentic qualities of agrifood data exists in studies of precision agriculture and points to instances of ‘governance with algorithms’, and the corresponding need for researchers to ‘[grapple] with the heterogeneous enfoldings common to digital platforms’ (Carolan 2020a, pp.1049–1050, emphasis in original; see also Gardezi
and Stock 2021). Aligned with the developing critical study of agrifood data relations, and in particular the liveliness of data, this paper contributes to this emergent literature by drawing attention to the agency of temporal relations and their embedding in data assemblages.

Our concern with data and temporality rests, in part, on how the intimate topologies of everyday life have been understood. Agri-food scholars have a long tradition of studying technological change, such as plantations, refrigeration and containerization diets (Freidberg 2009; Horowitz 2006; Rees 2013), and how change reverberates across food systems transforming actors such as farmers, processors, supermarkets and consumers (Bronson and Knezevic 2016; Burch and Lawrence 2007; Carolan 2020b; Cochoy 2020; Fraser 2018; Legun 2015; Miles 2019; Pilcher 2016). Ideas of topology, that focus attention on the transformation of spatial relations and which emphasize how the far is brought into relationship with the near, have provided insights into how globalizing processes have transformed everyday places, diets and food imaginaries (Brooking et al. 2011; Cronon 1991; Forney et al. 2018; Levinson 2006; Martin 2013). But, at the same time as multiple, fluid spatialities have been recognized, the independence of time, and the singularity of temporal experiences continue to be largely assumed. This has the effect of obscuring the generative agency of temporal relations in everyday worlds.

To ground our conceptual reflections on temporal relations the paper draws on a discussion of the efforts of Zespri (the farmer-owned cooperative marketing board for New Zealand kiwifruit) to promote more consistent kiwifruit quality across temporally (and spatially) dispersed supply chains. Zespri’s efforts are highly reliant on the use of a specific metric derived from the dry matter content of fruit as a proxy for taste quality. Dry matter is a useful proxy measure because between harvesting and consumption kiwifruit transform starch into sugars at a calculable rate. Therefore, the measurement of dry matter at the point of harvest provides a reliable indicator of future eating quality.

Among the disruptions to New Zealand’s horticultural industries caused by COVID-19 during 2020, including a national lockdown, the closure of the country’s borders to horticultural labour from the Pacific, and persistent concerns with the availability of refrigerated containers, the decision by the laboratory testing company Eurofins to stop offering a dry matter test for kiwifruit went largely unnoticed outside the dedicated agricultural media (Farmers Weekly 2020). Yet, the absence of dry matter measurements threatened to disrupt harvesting, shipping, marketing and interweaving financial relationships that have been territorialised around the calculation and maximisation of dry matter scores. This has been done in the pursuit of consistent taste quality which is the basis of Zespri’s market strategy to differentiate its kiwifruit from its competitors. In many respects this story is one that is familiar to infrastructure scholars where a small break in a complex assemblage deterritorialises much wider relationships with reverberating, non-linear effects (Law 2004). However, what we want to do in this paper is make the forced visibility of dry matter tell a differently critical story which takes as its inspiration Latour’s (2005) argument that at any point an actor can be decomposed into a heterogenous network (and vice versa) and that the relationships that are exposed can tell us a lot about the forms of agency enacted by that actor. Our story decomposes dry matter to show how its status as a matter-of-fact measurement black boxes a complex amalgam of temporal relations that otherwise might slip from view. We focus on the temporal qualities made visible by the generation of dry matter data, as a means of reflecting on how inserting temporality, as a matter of concern (Latour 2004), into data assemblages shifts our developing understanding of the work and worlds of agricultural data.

After providing an overview of our approach to data temporalities, we then consider temporality through three lenses: infrastructuring, performativity and ferality. Collectively these three lenses speak to the embeddedness of temporal relations in data infrastructures; the performance of time and what time performances make possible in data infrastructures; and the ferality (or unpacifiedness) of temporal data as it escapes the bounds of the agrifoods for which it is intended.

Data, temporality and agriculture

Comprehending time and its transformational possibilities has been a cornerstone of efforts to understand modernity and capitalism since the nineteenth century (Kern 1983). Marx, and then Thompson (1967) showed how the orchestration of time was central to reorganisation of work. Disciplining time was not only central to the production of capitalist labour, but more broadly a key project in the practice of colonial power (Hetherington 2014). The linked motifs in much of this work are those of speed and standardisation, a sense of the relentless compression of life, and of life organised around homogenous, linear time (Schivelbusch 2014).

An emphasis on the speed and standardisation narratives of modernity and capitalism glosses over, however, the enduring complexity of temporal relations (Bear 2014). For example, slowness is often imagined as the product of residual practices awaiting transformation. Yet, as Gregson et al. (2017) show, contemporary logistics, which is animated by the logics of speed and flow, is in actuality practiced through the strategic use of friction and interruption to manage flow. Who, or what, gets to experience flow, and conversely who, or what, is subject to the forms of managed hiatus that makes flow possible, represent time-knots that are
diagnostic of temporal power relations (Chakrabarty 2000; Sharma 2014). Speed is central to contemporary data imagina-
tories with velocity regarded as one of three qualities, along-
side volume and variety, taken as defining ‘big data’ (Kitchin 2014a) and the experience of living within computational worlds (Kitchin and Fraser 2020). Yet, as with the analysis of time more broadly, a focus on speed (in both its possibilities and perils) alone serves to obscure more complex temporal relationships enacted by and through data. Edwards (2010) for example has argued that friction is an integral part of data relations, while Bates (2018) has extended the idea of ‘data friction’ to show how control over the speed (or slowness) of data circulation becomes a resource subject to intense institutional politics that are territorialised in specific places and practices.

The relationship between speed and slowness is further complicated when the seasonal rhythms of life, death and decay are recognised as central to the organisation of bioeconomic assemblages such as agricultural commod-
ity markets (Cronon 1991; Henry 2021). Seasonality, and the desire to know its future rhythms, also points to what Beckert (2016b) calls the temporal disposition of capital-
ism whereby the development of a sense of what the future might hold is critical to inducing action in the present. Similarly, for Anderson (2010, 2017), work to anticipate futures represents dense knots of heterogenous temporal practices around forecasting, prediction and action that are taken-for-
granted but which profoundly shape how present and future imaginaries animate sociotechnical systems (also see Bear 2016). While Carse and Kneas (2019) argue that the proces-
sual, ever-becoming quality of sociotechnical systems such as ‘thinking infrastructures’ means that temporal relations are inevitably framed by the elusive effects of the promise of finishedness and the reality of unfinishedness (Bowker et al. 2019).

It is useful to imagine these temporal relationships through a topological lens. In the critical social sciences topologies have come to be framed in terms of spatial relations such as those between far and near (Allen 2016; Hinch-
liffe et al. 2012; Martin and Secor 2014). But topologies can also be imagined in temporal terms insofar as temporal orders involve bending past and future to meet in the present (Allen and Axelsson 2019). Just as spatial topology asks us to think about the assemblage of relations that enable far and near to be brought together, so ideas of temporal topol-
yogy ask us to consider the work of bringing the distant past (however defined) into intimate connection with the con-
temporary now. An example illustrates this need to consider topologies in both spatial and temporal terms. In the state’s work (among other actors) the past is routinely deployed through technologies such as statistics to bring temporally (and spatially) distant actors and activities into comparative relationships (Beer 2015; Daniel and Lanata Briones 2019; Joyce 2003; Miller 2004). Stories of progress, or decline, made visible in these comparisons provide the energy to maintain a perpetual rhythm of change. However, temporal connections, and the commensuration work that they enable, are only possible because of slow moving changes in the conceptualisation of what is relevant data, and how it can be collected and analysed. For example, Zespri’s current dry matter/taste relationship is the product of the analysis of taste testing in the Japanese market during the 1990s and the embedding of its results in orchard practices in the 2000s. Here, then, slowness is a necessary quality in creating the possibility of meaningful comparison as the past is carried into the present and used as a guide for the calculation of future possibilities. Consequently, worlds such as those generated by Zespri and its growers, are filled with forecasting and prediction technologies that make visible potential future states, as well as generating the imperative to act on the present as though those potential futures might come to pass and need to be either avoided or grasped (Furlong 2019).

**Infrastructure, performance and ferality**

Infrastructures are the stuff of everyday life. In John Law’s (2014) telling observation, infrastructures make possible those everyday miracles which often go unnoticed. Indeed, the condition of invisibility is often taken to be the state of ontological normality for infrastructures, while visibility represents an ontological rupture. In another register, however, infrastructures have become increasingly visible objects of political and economic concern because of the possibilities that they offer to both transform the present and reframe the future trajectories of cities, regions, and nations. In this vein Dodson (2017) talks of an ‘infrastructure turn’ in government policy-making that is being driven by the need to find new ‘spatial fixes’ to overcome the problems of low economic growth through the generation of new forms of investment opportunity. Much of this thinking focuses on those material infrastructures that, in Larkin’s (2013) words, represent matter that enables the movement of other matter. However, infrastructures can take other forms. Bowker et al (2019, p. 1) talk about the interweaving of material infrastructures with investments that, ‘organise thinking and thought and direct action across multiple settings and multiple temporal scales’. These investments have come to repres-
ent ‘thinking infrastructures’ that like material infrastruc-
tures generate possibilities of thought, and which channel decisions, materials and practices in specific ways. One key dynamic embedded in these ‘thinking infrastructures’ is the identification and marking of objects with qualities. Investments in form are powerful mechanisms through which the past is made to continually inhabit the present. These ideas
highlight the ways in which infrastructures are profoundly enabling, and simultaneously framing insofar as they create complex matrices of uneven possibilities that channels thinking in specific directions.

There is often a naïve empiricism wrapped in the cloak of technical sophistication when the question of what work data does is asked. Data, especially in its ‘big data’ forms, is assumed to represent the world as it is in a manner akin to Umberto Eco’s 1:1 map. Yet, unlike Eco’s map which carried a warning about the limits of representation, for the proponents of ‘big data’ where $N$ = everything the 1:1 map remains an aspiration rather than a folly (Anderson 2008). Assumptions that data represents the world without mediation obscures the performativity of data, and the key role it plays in performing temporal orders. As has become increasingly recognized the generation of data lies at the heart of prediction and modelling systems that offer the promise of knowing the future before it occurs. But to borrow from MacKenzie (2008) we argue that the data relations in these sociotechnical temporal assemblages are engines generating futures rather than cameras simply representing possible futures. In this sense data needs to be understood as active and lively rather than an inert medium from which meaning is extracted by human intermediaries.

Thinking about data in terms of infrastructure and performativity helps us comprehend the role of data in shaping the worlds in which we live. To some extent, however, each remains focused on human intentionality—it is the infrastructures, albeit not fully controlled and controlling, we create and our engagements with data as a performative agent. Are we, thus, trapped in the increasingly elaborate rearticulation of the pre-existing, and consequently too anxious to think beyond the data worlds we perform? A return to theory provides one means by which to make a cognitive leap into futures not already prefigured by existing categories and commensurations. But also perhaps our ‘thinking infrastructures’, their investments in form, and the data that populates them are less pacified and more feral than we think. We argue that lines of unpredictability lurk within the increasing certainty attributed to the calculative matrices that assemble the kiwifruit industry. Ferality provides a useful metaphor for thinking of data as an agent that acts outside its domesticated nature as a human construct to consider its yet untamed and wild interventions in these assemblages.

**Dry matter, data and kiwifruit**

Ideas of lively data provide a useful framework to explore some of the emerging implications of changing data relations in New Zealand’s most significant horticultural export industry following the introduction of dry matter as the dominant metric of fruit quality. In 2020 exports of kiwifruit exceeded NZ$2.5 billion (Horticulture Export Authority New Zealand 2021). While the global production of kiwifruit is dominated by China and Italy, exports from New Zealand (almost exclusively from Zespri) comprise over 40% of the total global export trade in the fruit (Global Trade 2021). The 2020 export returns represented a 36% increase in value since 2018 because of significant increases in returns per tonne from NZ$3661 in 2018 to NZ$3989 in 2020. The future value attached to kiwifruit can be seen in the June 2021 auction of growing licenses by Zespri. This auction saw licenses for the SunGold variety reach an average tender price of NZ$500,000 a hectare up from NZ$400,000 in 2020 (Rennie 2020, 2021). The effects of future value can also be seen in the growing value of orchard land with SunGold orchards being sold at more than NZ$1 million a canopy hectare (Rennie 2021). All these values, materialized in returns to growers, bids for licenses, and orchard mortgages rest upon the prices paid for kiwifruit, and crucially how export returns are calculated and distributed to growers by Zespri. For example, in the 2020/2021 season SunGold kiwifruit averaged a record NZ$12.46 a tray (New Zealand Herald 2021), but the actual payments received by growers were varied across a range of criteria including the timing of their harvest, and the taste of their fruit as calculated by the Taste Zespri programme (New Zealand Kiwifruit Growers 2021b).

Amid the range of SunGold kiwifruit qualities, it is taste, calculated through the dehydration and weighing of small segments of randomly selected fruit, that has been enacted as a (or the) critical test of strength for claims to quality, and linked claims to the benefits of that quality (Zespri 2021b). In the early 2000s Zespri’s newly marketed gold kiwifruit faced complaints that its taste was not consistently appealing. Through a process of taste testing with Japanese consumers (Zespri’s largest market), Zespri identified a strong correlation between dry matter and consumer preference (Heywood et al. 2017), leading to higher dry matter percentage being taken as an indicator of a sweeter, more desirable fruit (Plant & Food Research 2007). Research also demonstrated that there was predictable temporal relationship between the dry matter percentages calculated at harvest and the dry matter of fruit at the point of sale, despite the months that kiwifruit spend in storage. This correlation, and temporal stability, led to the development of the Taste Zespri program, which identified specific ‘bands’ of predicted consumer appeal based on the measured dry matter of a sample of fruit from orchard and, subsequently, tied grower returns to those ‘bands’. The premium awarded for taste during the 2021 harvest ranged from 32% of total payment to orchardists for Green kiwifruit to 46% for Organic Gold kiwifruit (Zespri 2021a). These bands are performative insofar as they do not simply indicate quality but have become targets as orchardists are incentivized to produce fruit within the more
desirable bands through pricing mechanisms that reward higher dry matter scores (see Fig. 1).

In an interesting inversion of the claims made about terroir for products such as wine, Zespri’s strategy is to argue that ‘How is more important than Where’ (Zespri 2021c). This ‘how’ is what Zespri calls the ‘Zespri System’ of integrated production and distribution which it uses to create and maintain its global grower and customer relations (Zespri 2021d). The positioning of taste, and in particular the dry matter metric, as an ‘obligatory point of passage’ (Callon, 1986) within the ‘Zespri System’ has taken years to develop; but its measurement is now used to ensure that growers harvest kiwifruit at specific stages of maturity to maintain taste standards. Zespri’s erasure of ‘where’ echoes the long history of the global agrifood system and its success in occluding the relationships between food and place (for example see Mintz 1986). However, despite the discursive erasure of ‘where’, regional variations in dry matter do exist and these variations have caused dissent in the use of dry matter-based premiums. For instance, as dry matter became increasingly important, some growers complained that dry matter levels did not necessarily distinguish the good practice and skill of the grower and that price discrimination on the basis of dry matter was illegal under the Kiwifruit Export Regulations 1999 (New Zealand Kiwifruit Board 2017). Despite these complaints and associated legal challenge, dry matter has been firmly embedded as the criteria around which quality revolves.

The performances generated by the entanglement of dry matter bands and financial returns are the product of a commensuration infrastructure that transforms fruit into comparable metrics (Henry 2017). The actual practice of data generation involves randomly sampling fruit and drying slices taken transversally from the center of the fruit. The dry matter percentage is the ratio of the fresh and dried weights of each slice. Once water is removed from kiwifruit the remaining dry matter is largely comprised of starches which are gradually converted to sugar as the fruit ripens. This transformation accounts for the correlation between dry matter with customer taste preferences for fruit with sufficient sweetness to balance its acidity (New Zealand Kiwifruit Growers 2019a). While the testing of dry matter is a relatively straightforward process, it is also destructive. This creates a tension as the sampling procedure needs to be robust enough to account for spatial differences with orchards and inter-vine variation, without destroying so much fruit so as to impact on the financial viability of the orchard. Because of this balancing act between representativeness and destruction in the generation of dry matter scores for blocks of kiwifruit, sampling only occurs at the time of harvest. But harvesting itself is a product of dry matter. Harvesting is a complex knot of material and temporal relations. The date of harvesting is negotiated by growers and packhouses around evolving dry matter expectations from Zespri since both actors have an interest in the supply of fruit that meets acceptable dry matter levels (New Zealand Kiwifruit Growers 2021b; Skipage 2022). Moreover, harvesting is the culmination of sustained work over the previous months intended to promote dry matter scores. For example, to successfully position fruit within the desired dry matter bands, packhouses will provide crop management information to supplying orchardists, including the timing and extent of pruning, the girdling of vines, the level of water and fertiliser inputs, and the use of growth stimulants (New Zealand Kiwifruit Growers 2021a). Consequently, harvesting is the culmination of a set of temporal practices that induce material changes in kiwifruit, and the beginning of new practices that revolve around using cool storage

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**Fig. 1** Zespri Gold Kiwifruit & Service Payments 2019/20. Zespri (2020, p. 9)
over several months to allow fruit the time to transform the starches, made visible by testing, into the sugars desired by consumers.

Dry matter aligns these temporal practices, and so the withdrawal of dry matter testing by Eurofins (and the resulting disruption to Zespri’s incentive pricing) represented an immediate tear in the commensuration infrastructure developed by Zespri and assumed to be stable and finished. However, infrastructures are ontologically fuzzy because their material and conceptual boundaries are indeterminate and unstable. This indeterminacy is often expressed through the question: where does an infrastructure begin or end? But equally this question can be reframed as: when does an infrastructure begin or end? Carse and Kneas (2019) argue that most infrastructures are characterized by the temporal condition of ‘unfinishedness’ which suggests a constant process of becoming as the varied material and social relationships that make them possible are continually maintained, remade, and altered. While the idea of becoming speaks to the present and what might emerge in the future, it should also lead us to consider past infrastructural territorialisations that have stabilized configurations of data collection technologies, categories, and analytical methods. Dry matter data, the qualities it represents, and the decisions it supports, are collectively the result of taste preference projects that go back over three decades beginning with the development of a Brix test to measure the sugar content of kiwifruit in the late 1970s. The development of the Brix test, subsequent work to evaluate taste preferences that began in 1983, the gradual incorporation of dry matter taste data into evolving definitions of kiwifruit quality from the early 2000s, all serve to illustrate the unfinishedness of taste as a relationship of concern for Zespri (and its precursors). Moreover, it is the state of unfinishedness that also folds together future possibilities as new varieties of kiwifruit, including red varieties, are projected to continually introduce variability into taste and quality relationships.

While unfinishedness requires us to try and avoid seeing infrastructures as invariably stable, it should not stop us from seeing the stabilising effects of infrastructuring. This can be clearly seen in material relations, but it is equally so for temporal ones as well. Infrastructures draw the past and present together. The Taste Zespri programme connects past taste preferences to present grower, processing, and consumer practices to govern the future performance of those practices (Heywood et al. 2017). Dry matter exists at the center of Zespri’s marketing strategy to present and maintain its fruit as an Olympic standard (Busch 2011). Since 2006 Zespri has set ‘bands’ that define the thresholds that fruit need to meet to be accepted into its Taste Zespri Grade (TZG) Class 1 inventory. In 2006 and 2007 50% of kiwifruit from a maturity area needed to contain at least 14.5% dry matter, and these combined percentages have been gradually increased (Heywood et al. 2017; Plant & Food Research 2007). Simultaneously it is also used to define Minimum Taste Standards (MTS). MTS is a filter standard, under which kiwifruit will not be accepted by packhouses, and by extension Zespri, for sale in international markets such as the lucrative Japanese one. Fruit failing to reach the MTS is routed into the New Zealand domestic markets sans Zespri branding (New Zealand Kiwifruit Growers 2021a). So, while dry matter performances are used to maximize value, they are integral to avoiding the possibility of no value being produced.

These shifting premium ‘bands’ reflect Zespri’s projections of market demand and preference as well as expectations about likely dry matter production. By rendering the future calculable, by providing an anticipation of what fruit will taste like in the future, the assemblage of dry matter testing inter alia enables the performance of a future orientated temporal disposition critical to capitalism (Beckert 2016a). But these anticipations already come preconfigured insofar as they are fashioned from years of past feedback from customers (predominantly wholesalers in high value markets such as Japan) and the ongoing evolution of orchard practices and technologies to enhance dry matter. Data assemblages, such as those created around dry matter, are then eventually marked by deep path dependencies, often literally as Starosielski (2015) points out, grooved through legal and physical spaces. Conceptually as much as materially, these past investments in ‘technical and social forms’ (Desrosieres 1998, p. 8) provide a body of categories and performative relationships between categories that continue to configure future possibilities (Bowker et al. 2019, p. 1). These investments, and what they produce, fold past and present together. But it is an uneven relationship because it requires those investments in form to become the obligatory points of passage through which the present (and future) must pass to understand itself. In other words, the kiwifruit industry is only able to understand its present and future by going through a frame defined by what it has done in the past.

Seasonality rather than speed per se frames kiwifruit’s temporal order (see Fig. 2). The kiwifruit growing season in New Zealand starts with winter pruning before the vines begin to regrow, flower and be pollinated in spring from September to November (New Zealand Kiwifruit Growers 2018). Kiwifruit berries grow through summer, before harvesting begins in early autumn and continuing until early winter. Harvesting itself has a temporal sequence with gold varieties starting to be picked before green kiwifruit. Cool storage significantly extends the viable market window, but there are distinct storage temporalities for the kiwifruit varieties. The most recent addition to Zespri’s range -Zespri Red kiwifruit- does not store well and has a short sales season. Consequently, it is pushed onto markets early. Conversely, Zespri Green kiwifruit can spend much longer in storage.
than either of SunGold or Zespri Red. Moreover, by using local seasonality through its network of licensed growers in Italy, France, Japan, South Korea, and Australia, Zespri creates a global time of in-season plentitude (Zespri 2021a). By strategically using seasonality, the material qualities of dry matter and the transformative quality of storage to create all year around availability for fruit that are desirable, Zespri has used dry matter data to align the multiple temporal relationships of kiwifruit around ensuring the regularity of market supply and quality.

Nonetheless the successful production of a desired dry matter scores is not straightforward. Maximizing dry matter requires degrees of luck in relation to external environmental conditions such as temperature and rainfall, and the temporally intricate orchestration of orchard management, and post-harvest practices. For example, a critical variable in dry matter production is the management of light within orchards (New Zealand Kiwifruit Growers 2018). Consequently, after the end of the harvest, and before budbreak in spring, growers have a relatively short period of time to open orchard canopies through pruning, and they also have a small window for a second round of summer pruning to remove excess vegetation growth. Successful pruning enables more light to reach vines and improves both fruit size and dry matter. Likewise, irrigation needs to be carefully governed because too much water, too often, increases fruit size and dilutes dry matter percentages. Over time other dry matter practices on orchards have developed to include trunk girdling, crop thinning, and root pruning that are intended to maximise the predictable development of dry matter (see Fig. 3).

Other problems lie in its materiality as data. A core narrative of contemporary discussions about data is the argument that data has historically been difficult, costly and time-consuming to generate and interpret (Kitchin and Lauriault 2014). In turn this has meant that the relations that data rendered visible were slow-moving and coarse grained. Often these problems are set against the kinetic qualities of ‘big data’. Traditional dry matter testing can be framed in this way. Because dry matter testing is destructive, detailed sampling protocols must be followed to create consistent and comparable results with as little loss as possible. Sampling takes time, as does the process of preparing samples for testing. Because of the financial link between dry matter and harvest clearance in the ‘Zespri System’, the testing and reporting system come under strain at time critical moments. In contrast, changing instrumentation technologies, such as faster and less destructive measurement through the use of Near Infrared (NIR) in orchards and packhouses, promise, what Kitchin (2014b) calls a deluge of timely data. It is a narrative that is being articulated by Zespri in its recently announced Horizon programme which seeks ‘innovation at speed’ through investments in machine learning automated instrumentation to produce more, and faster, data (O’Neill 2021).

Instruments, and their affordances, are powerful mediators in performing kiwifruit temporalities. The introduction of Brix testing as a measure of kiwifruit maturity in the early 1980s elevated the refractometer -a simple optical or digital handheld device for measuring Brix levels- into a critical device for determining the timing of harvesting (Zespri 2008). In the process it turned the orchard into a ‘centre of calculation’ (Latour 1987). Increasingly, however, the refractometer-based measurement of Brix levels at harvest were problematized as being an unreliable indicator of Brix at the point of consumption. The shift to dry matter as the paramount metric better able to predict taste at the point of consumer sale moved the point of calculation away from orchard-based refractometers to the lab-based dehydrators and scales used to determine dry matter. As the geography of data production shifted from orchards to the lab so too did the power to determine the timing and pace of action within the temporal order established to govern harvesting.

The orchard level search for dry matter data has also become increasingly fine-grained as packhouses have begun using NIR technologies to assess individual kiwifruit as

Fig. 2 Kiwifruit Lifecycle. Adapted from Stokes (2019, p. 25)
they are graded (New Zealand Kiwifruit Growers 2018, 2019b). The use of NIR in this way enables packhouses to salvage fruit that meets the MTS, but which would have been rejected because of its size since small size is correlated with lower dry matter levels (Mount Pack & Cool, ND). NIR also enables fruit to be separated with greater precision to optimize the timing of storage and its release onto markets. Again, however, the growing use of NIR shifts power within kiwifruit assemblages towards packhouses.

Devices such as NIR are incorporated into data mining work that uses the massive amounts of data generated by automatic grading systems (amongst other systems) adding further complexity to the temporal orders of the kiwifruit industry. So, for example, Zespri alongside other companies including the government’s innovation agency Callaghan Innovation recently established PlantTech to develop AI and machine learning techniques to improve things such as yield estimation (Callaghan Innovation 2021). However, no matter how big or swift data is, its predictive potential is firmly tied to its relationship with the past, because any data analysis, ‘can only tell us about what has already happened. It cannot tell us about things that have never happened’ (Madsen et al. 2019b).
Seen in these terms, the problematization of taste represents therefore relevant from that which is outside and irrelevant. Prehensible territorialisations, delineating what is inside and represents an effort to try and stabilize complexity into commodified and more feral than we think. Notions of overflow in form, and the data that populates them are less sent and future performances to the legacy of previous ones. Structures. As some point data becomes a lock that fixes pre-constructed for them by existing data categories and infra-structures. But these possibilities only exist within the frame mining that this enables, provides a rich source of possibilities and businesses, with established methodologies and modes of analysis, and a record of producing meaningful answers (Kitchin and Lauriault 2015, p. 465). For example, despite Zespri’s desire for ‘innovation at speed’, the same workers within Zespri’s technical team have argued that while the opportunity for more data to be produced more quickly is enormous, this potential deluge of data is only useful if the quality is high and can be integrated into the existing commensuration infrastructure developed through years of small-scale surveys and experiments carried out by organisations such as Zespri and Plant and Food Research. Meanwhile, the scope remains to reconsider, remake and reinvest in different forms of classification and categorization. Reinvesting in forms comes with a cost that stems from the temporal dislocation whereby previous data structures can no longer be commensurated with data structures in the present. Under these circumstances temporal topologies become frayed or dissolve as data infrastructures splinter.

The agency of data in performing temporal orders creates implications for kiwifruit actors. While new, and more, dry matter data can provoke and require new performances it cannot alone generate new worlds. Zespri’s increasingly fine-grained analysis of its fruit, and the subsequent data mining that this enables, provides a rich source of possibilities. But these possibilities only exist within the frame constructed for them by existing data categories and infrastructures. As some point data becomes a lock that fixes present and future performances to the legacy of previous ones.

But perhaps our ‘thinking infrastructures’, their investments in form, and the data that populates them are less pacified and more feral than we think. Notions of overflow provide a starting point to consider data ferality. Framing represents an effort to try and stabilize complexity into comprehensible territorialisations, delineating what is inside and therefore relevant from that which is outside and irrelevant. Seen in these terms, the problematization of taste represents a critical frame from which Zespri has territorialized its kiwifruit production system. As we have seen key to the maintenance of this framing has been, and continues to be, the tightly bound relationship between dry matter, temporality, and consumer preferences. As has already been argued, the shift towards making kiwifruit value be partly determined by dry matter metric provoked anxieties from growers because of the ways in which the testing unsettled existing notions of what (and who) constituted a ‘good’ grower able to effectively orchestrate growing time. This was particularly the case in those situations where dry matter testing exposed the effects of variable environmental conditions which were the product of the vicissitudes of space and time, independent of the performance of good orchard practice. Nonetheless dry matter has been powerfully domesticated. But the dry matter data still contains the ability to enact an agency beyond the intentions of its framing because it can highlight ‘new actors and problems and de-prioritise others, which can in turn suggest new governance solutions which change both our relationship with the natural world, and inter-human relations or politics.’ (Ascu et al. 2018, pp. 908–909). So, for example, the withdrawal of testing by Eurofins focused attention on the weakness of a single laboratory as the obligatory point of passage for harvest authorization (Callon 1986). In this way the success of data to create a relationship around which everything else moves also generates a haunting anxiety about the possibility of the data failing to exist.

Ferality can be seen as the product of absence, but it can also be generated by plentiful. A feature of contemporary worlds is the ongoing mediation of everyday decision making by the proliferation of sensors, and their connectivity. The capacity and analytical protocols increasingly embedded in these devices have marked a step change in the use and expectations of environmental data. Spatially and temporally finer-grained data is expected to provide stronger proof of previously uncertain relationships, and at the same time a temporal shift to continuous assessment can identify variability in practices and qualities much more effectively.

Yet, ferality lurks within the promise of data plentitude. The possibility of accurate, non-destructive testing of individual fruit at mass scale makes possible new grower and buyer practices. Already, for example, the South Korean instrument maker, Sunforest, has developed its H-100 series of handheld NIR scanners, which it has calibrated for kiwifruit with the assistance of Zespri (Hull 2019; Li et al. 2018). Devices such as the H-100 create new forms of individualized visibility, disconnected from existing laboratory testing regimes, that shifts attention from the credence claims made by Zespri about the quality of its fruit to the measured properties of individual fruit (see Fig. 4). For growers this might mean the ability to shift orchard management practices in response to the qualities of fruit being produced from single
vines. But at the same time, it might also enable the increas-
ingly fine-grained (re)valuation and assetisation of orchard
land. Packhouses might seek to contract specific vines, or
parcels of orchards rather than orchards in their entirety,
which would in turn create reverberations throughout the
industry’s harvest labour practices which have been tradi-
tionally based on piece rates and large teams of pickers to
attend to the whole of an orchard. For fruit buyers individu-
alized fruit scores might enable an ever-finer differentiation
as taste maximizing consumers search for specific dry matter
percentages. Supermarkets are already widely criticized for
appearance criteria that generate enormous amounts of food
waste. The ability to digitally peer into fruit could conceiv-
able increase waste as consumers search for specific fruit,
at the expense of others, that meet their specific palate pref-
ences. This shifts the time at which taste is first assessed
from the time the first bite is made (usually at some point
after having paid for the fruit) to the moment the fruit is
scanned prior to purchase. In this case existing topologies
are bent by feral data as people can look inside fruit before,
rather than after they cut into it. Individualized fruit test-
ing also creates the possibility of a novel commensuration
framework that sits at odds with Zespri’s brand strategy
based on the link between trust and quality. Rather than a
point of difference, dry matter might become a rogue com-
mensuration framework that enables consumers to directly
compare individual fruit from different producers outside a
carefully curated brand framework. While speculative these
possibilities are not implausible, and they suggest ways
in which data might become generative of unpredictable
actions by creating new ‘sites of grip’ as actors use the
possibilities offered by different data technologies, such as
handheld NIR scanners, to configure alternative connections
to dry matter (Ash et al. 2018).

Conclusion

It is a common claim that agrifood governance and policy
making is being revolutionized by new data relationships
(Bronson and Knezevic 2016; Fraser 2018). The application
of ‘big data’ and machine learning to activities such as Pre-
cision Agriculture are taken as examples of this revolution.
However, such claims mask deep continuities in agrifood
relationships (Miles 2019). These continuities suggest that
a critical feature of agrifood data research is the need to
understand the ways in which continuity is practiced through
infrastructural and performative data relations.

This paper has argued that time and temporality are
excrucial to the ways in which evolving data relationships
are simultaneously generative and disruptive of everyday
worlds. Beyond a sense of time as an external marker of
change, the paper has suggested temporalities, existing in
the multiple, are lived experiences characterized by uneven-
ness and diversity. Worlds are made through the practices of
time work, and that time work is practiced in assemblages
profundely shaped around evolving data relations. Conse-
quently, the very fabric of everyday worlds rests upon align-
ments of past-present-future, and we need to ask: How is
this done? What relations are maintained? When is it done?
What future possibilities are closed off? And what might be
the effects of trying to use data temporalities to fold past-
present-future in different ways?

Woven through this paper is the argument that temporal
relations are embedded in data, and that those relationships
are deeply generative. Data is lively in ways that transcend
human centered ideas of agency (Lupton 2016). Data forces
other actors to respond to it in unpredictable ways. Invest-
ments in forms such as dry matter tie together present and
future by using past events to structure possible future ones.
There is, however, a sting in the tail. Connections can be
generated to the extent to which data remains commensu-
able across time, but commensuration itself is problematic
because of the ways it channels everyday decisions into
grooves that are bound to the past, but which paradoxically
continually threaten to escape being pacified and to produce
feral possibilities. Consequently, greater attention needs to
be given to temporal relations within agrifood data territorti-
alisations because in doing so we become much better able
to recognise the imagination and performance of temporal
agency. Agency that has been largely ignored in agrifood
scholarship, but agency that is nonetheless deeply power-
ful in organising day to day practices, and binding those

Fig. 4 Sunforest’s Jay Hwang with a handheld kiwifruit NIR tester. Source Tainui (2019)
practices to past, present, and future. By paying attention to the temporal dimensions of data relations we become better able to see how the future is a product of the past, and to envision different agrifood futures, and how these might be brought about.

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