

METROLOGY AND SUSTAINABILITY: USING SUSTAINABILITY AUDITS IN NEW ZEALAND TO ELABORATE THE COMPLEX POLITICS OF MEASURING



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1. Introduction

In this article, we engage with theorisations of metrology to gain insight to the complex dynamics associated with the adoption of indicator metrics to verify the sustainability of primary sector production systems. More specifically, we examine the emergence of sustainability as a measurable and measured quality of food and primary production systems as an extension of recent changes in the governance of these systems through which new technologies of audit have been enrolled to networks of producers, consumers, retailers, scientists and other actors. Such audit schemes create dense arrays of measures, standards, protocols, thresholds and sanctions that are increasingly influential in organising the practices of primary sector producers (and consumers) around the world (Busch and Bain, 2004; Giovannucci and Ponte, 2005; Hatanaka et al., 2005; Le Heron, 2003; Marsden, 2000; Mutersbaugh, 2008; Ransom et al., 2013). The result, as we suggest in a previous publication, is the consolidation of a ‘metric-centric’ approach to pursuing sustainability outcomes in agri-food systems established social science explanation, especially in terms of nonhuman actors in socioecological networks. To date, metrics commonly appear in one of two analytical modes common to orthodox theorisations of socio-worlds, as either: 1) bystanders to more pertinent dynamics of change and control no more relevant than the typeface used in the publication of Marx's *Capital* or 2) inanimate pawns deployed by social and economic agents to enact power. In other words, metrics are either inert signifiers, or, to the extent that they appear to exert social power, tools wielded by institutions, groups or individuals to organise worlds. In this article we propose that, beyond mere passive participants, metrics should also be understood as agents when we theorise many agri-food dynamics. We purposefully refer to metrics as agents not to establish any equivalency to humans, but to highlight the potential for metrics to initiate change beyond the expectations, intent and control of humans.¹ Put differently, sustainability has become ordered around the enactment of sets of numbers that do much more work than has previously been acknowledged. To use the words of the editors of this special issue: ‘[t]he consumption of food is simultaneously the consumption of numbers’.

¹ Our use of agency conforms to the diverse treatments of non humans in ANT (Sayes, 2014) and invokes Mol's (2010: 255) characterization of the purpose of ANT to “... open(...) up the possibility of seeing, hearing, sensing and then analysing the social life of things and thus of caring about, rather than neglecting them”.

The need for further theorisation of the purportedly neutral and inert world of measures (and the grades, standards, protocols, thresholds and sanctions they underpin) is evident in the recent discussion surrounding the potentially negative outcomes of pursuing sustainability via measurement. That metrics are being identified as a problem is obvious without reference to theorisations of metrologies. Bell and Morse (2008: xvii) exemplify a common understanding, arguing that any attempt to measure sustainability is a “futile exercise of measuring the immeasurable”. They further claim that quantifying sustainability has not succeeded as an approach to achieving it, noting that quantification has merely resulted in “measuring things that can be measured and not things that should be measured” with the result that sustainability becomes “defined by the parameters that can be measured rather than the other way around”. In their critique, metrics of sustainability are a problem because of inherent inaccuracies of the measures and their inappropriate use by other (human) agents. In this case, metrics merely signify the work of other agents exercising social and economic power.

The wider literature on agricultural ‘grades and standards’ also implies that metrics are of interest as the tools of powerful institutional actors. For example, it is often argued that: the measures at the core of organic certification have been co-opted to serve the interests of corporate capital (Pollan, 2006); or the measures in farm production systems have driven unsustainable intensification of farming practices by male farmers (Jay, 2007). This ability of metrics to translate the power of other actors and institutions is further, and amply, demonstrated by the example of nutritional measures through which companies, development agencies and governments, have legitimised the transition to unsustainable diets in the Developing (and Developed) World (Dixon, 2009; Dixon et al., 2004; Scrinis, 2008).

While such work draws attention to important aspects of the social dynamics associated with the introduction of measures into the production of food, the representation of quality or the disciplining of diets, the world of numbers in agri-food scholarship nevertheless remains under-examined. At the very least, the concerns raised by Bell and Morse (2008) indicate contexts in which the question of representation are highly relevant; and, in the metric-centric worlds of sustainability audits, it is imperative to question whether a measure accurately represents an agroecological reality. Furthermore, and on closer inspection, the seemingly inefficacious metrics of food quality and nutrition are potential tools of other agents of social power or coordination. That is, they do social-economic work to which other important actors conform. In the sense of

Barthes' mythologies (Barthes, 1972), they are the visible representatives and vectors of other sociologically understood powers and it is important to recognise their roles in the enactment of such powers.

In this article, however, we use the theoretical work of metrology to extend more common approaches in social scientific studies of the processes, institutions and dynamics around sustainability; that is, we intend to focus on the different pathways and outcomes that are enacted between state regulation, industry actions, voluntary protocols and codes of conduct, formal market audit mechanisms, individual voluntarism or community governance through the agency of metrics. Following the work of Barry (2002), Callon et al. (2007) and Mitchell (2002, 2008), a metrology approach re-centres analysis of networks of economic activity towards understanding the ways that metrics order or structure behaviours and practices, in effect, creating a framework to which people and things adhere. This effectively unsettles the usual causality that implicitly informs social scientific analysis and places the human or institutional actor as the essential locus of agency in agri-food systems or networks. Such an approach recognizes that, within the process of establishing measures of sustainability, metrics assume authority by setting the parameters for appropriate practice. It shows that, rather than mere representatives or tools of other powers, metrics (as non-humans) also do work at the intersection of social, economic and ecological worlds as argued by Bennett (2010) and Mol (2010).

In effect, our work in this article is to elaborate a rapprochement between established critical work on metrics such as Bell and Morse, Dixon and Scrinis and the new metrological approaches by acknowledging three (of many) aspects of metrics. To achieve this, we first introduce a metrology framework for understanding sustainability and audits. We then apply this framework to broaden our understanding of three case studies of the application of sustainability audits from New Zealand. Through these case studies, we propose that the entrance of metrics can be: 1) as pure measures, 2) as tools to promote practice and to order production chains and 3) as agents that compel their use. No matter the initial engagement with metrics, however, all three aspects become evident in each case study in a manner that points to the value of dialogue between the different critical approaches to sustainability metrics identified in the introduction.

2. Understanding sustainability and market audits in NZ through the lens of metrology

Over the preceding ten years, we have been active participants in the critical examination of audit systems in food production. Throughout this time our focus has largely been oriented to the

emergent dynamics of social and society-environment relationships driven by audit criteria. Based on this work, we have argued that the measures involved in audits are negotiated on the basis of their public legitimacy (Rosin and Campbell, 2009) and their practicality and acceptance amongst those implementing and being subjected to them (Campbell and Rosin, 2011). These contributions positioned us as a critical voice in debates regarding the development and meaning of metrics as well as the political implications of their implementation. Despite these insights, we were increasingly frustrated in our efforts to elaborate the dynamics of social change that could not be adequately explained in terms of power structures and human agency. In other words, it was increasingly apparent to us that the metrics themselves were impelling many of these changes.

Our emerging engagement with theorisations of metrology and growing awareness of the significance of the third aspect of metrics (their vitality) in food systems has been strongly influenced by the wider context of New Zealand-based scholarship that points towards such dynamics. A prime example of the insights to be gained in using a metrology approach is Henry and Roche (2013) examination of the recent history of the New Zealand meat industry. They argue that the creation of meat standards, genetic measures of stock 'quality', as well as the creation of a global standard for Wagyu beef production all became central features in re-organising the production, processing and ownership of elements of the meat industry. Another example is that provided by Cooper (2015) in his analysis of the metrologies of carbon emissions trading (or failure thereof) in New Zealand.

For the purposes of this paper, we will re-narrate existing engagements with metrics of best practice (mostly addressing sustainability issues) in three economic settings in New Zealand:

- the evolution of the KiwiGreen and GlobalG.A.P. audits and subsequent revisions to their metrics within the kiwifruit export industry,
- the development of a local protocol for positioning New Zealand wine at the premium end of the world table wine market and,
- the experimentation with brand demarcation and management of commercial products through the delineation of both measurable and non-measurable qualities by tribal groups of New Zealand's indigenous Maori.

Each of these occur in the context of attempts to deploy metric centric approaches to sustainability. Our examination of the operationalisation of sustainability measures within these production sectors provides insight to three aspects of metrics in the New Zealand primary sector.

Taking a metrological approach to understanding the creation and implementation of particular cases of sustainability auditing requires us to reflect on a series of key questions about the processes, decisions and materialities through which particular metrics became important in the operationalisation of specific audits. Our representation of metrics as multi-faceted participants in these case studies follows similar work in the realm of statistics and gymnastics. Desrosieres (2001) elaborates the plurality of understandings of economic statistics ranging from the pure numerical emphasis of statisticians, to the normalising of practice of accountants, the pragmatic engagement of policy makers, and the constructionist assessments of social scientists. In a different context, Kerr (2014) examines the role of gymnastics apparatuses in competitive gymnastics, showing that they are expected to standardise competition, but vary substantially between locations in their interaction with gymnasts. Furthermore, she points to the potential for video tracking of practice and performance to erode the power of exclusive insight held by the coaches. In our case studies, three aspects of metrics are particularly relevant:

- 1) Metrics as indicators or measurable representations. As measures, conceptually at least, metrics appear in the case studies as inert things. It is, however, essential to ask questions as to how particular values are 'fixed', indicators are selected and then embedded into wider audits of sustainability. Two of the cases demonstrate the degree to which international market requirements influenced the adoption of particular 'global' indicators rather than an endogenous assessment of sustainability dynamics in New Zealand. We must also consider measurement itself as the product of the interactions among a range of actors and dynamics that act together to co-produce a (temporally) stable outcome. The process of stabilisation can be driven in part by scientific knowledge production, by social convention and, importantly, by the materialities of networks of action.
- 2) Metrics as tactical tools. In each of the case studies, metrics are undeniably an element of attempts to attach qualities to products that better position them within markets that are increasingly aware of the social and environmental impact of management practices. In one case study, the tactical value of metrics emerged subsequent to the adoption of measures focused on more immediate concerns regarding pest control. In the other two, the potential application as tools was a primary intent in the adoption of metrics. By their very nature, however, metrics work

to standardise and normalise management practices in a manner that facilitates shared marketing opportunities (e.g., labelling).

3) Metrics as vital agents. It is also necessary to re-focus our enquiry from specific policy initiatives and platforms, or from particular institutional actors like industries, firms, farms or individuals, to examine the capacity for metrics to re-order economic worlds. The case studies indicate that metrics are impelling a reordering specifically at the points in the value chain that link farm and orchard or enterprise-level practice, through various intermediaries and eventually to destination retailers, locations and institutions. Their action in such situations is vital (Bennett, 2010) to the extent that their participation in agri-food systems engenders change beyond the ordering of practice around the sustainability goals for which they were intended, including altered power relations among human participants, new forms of coordination or the translation of culturally specific understandings of legitimacy (as will be demonstrated in the three case studies, respectively). This provides a more complex understanding of metrics as enactive and constitutive of particular realms of action that may or may not facilitate the elaboration of alternative forms and networks.

The following case studies will examine how these three aspects of metrics are present in the emergence of three distinct sustainability audits that have been negotiated, contested and enabled, within particular industries and other groups in New Zealand. In each case, different dynamics demonstrate the ways in which contrasting social and economic contexts nevertheless embed a metric-centric approach to sustainability and consequently reorder networks and social practice within those economic worlds. The following cases reveal that our understanding of metric-centric approaches to sustainability cannot be reduced to a narrow focus on a specific aspect of metrics, and that the enactive qualities of metrics are equally relevant and omnipresent as is their role as measures and political tools.

3. Case study: kiwifruit

Sustainability metrics have been a strong influence in the New Zealand kiwifruit sector since the early 1990s. As a case study, the sector illustrates the dynamics that can ensue when metrics are introduced as seemingly straightforward measures used to facilitate management and best practice. The re-emergence of the sector from a crisis of oversupply and excessive reliance on chemical pest controls has been extensively studied as an example of the adoption of sustainable practices via audit mechanisms within export oriented agriculture. Prior research has documented the

transformation from the export of bulk commodity kiwifruit to quality audited and marketed kiwifruit capturing the top end of the world market (Campbell and Rosin, 2008) and the emergence of new conventions and cultural norms within kiwifruit production (Rosin, 2008; Rosin and Campbell, 2009). In this account we highlight the integral involvement of metrics in this process, rooted in the normalisation of IPM practices.

3.1. Introducing metrics as measures

Prior to the 1990s, kiwifruit metrics were relatively simple. A pest-free status was achieved through a heavy, calendar spraying regime of pesticides, and fruit was graded according to size and visual qualities. Kiwifruit (*Actinidia deliciosa* or Hayward Green) were graded into Class 1 (Export), Class 2 (Domestic) and, after 1991, Certified Organic. The former had to be blemish free and of uniform shape, while export markets were differentiated according to specific size requirements (e.g., Japan tending towards larger and Ireland towards small fruit) (Campbell et al., 1997). At the time a nascent research program which was interrogating Integrated Pest Management (IPM) approaches as a path to more rational pesticide use was active at HortResearch, the government funded horticultural research organization. In this program, researchers began to develop metrics that established the threshold pest numbers that defined economically rational triggers for pesticide application. Initially, these new metrics drew minimal interest from the sector and remained measures that had yet to perform as tools or to generate agency.

The relevance of the IPM measures became more apparent in the early 1990s when a shipment of fruit to Italy encountered new EU regulations and was rejected due to the detection of pesticide residues. The novel danger of rejected shipments undermined the legitimacy of the practice of calendar spraying for pest control and IPM offered a viable solution. Campbell et al. (1997) documented how the combination of market crisis (with increasing supply competition from South America), industry insolvency and the collapse of commodity-style exporting of green kiwifruit elevated a new set of demands for which the previously disregarded IPM metrics emerged as a potential solution. Beyond their initial role in redefining what good kiwifruit was, these new measures provided the foundation for the legitimacy of more extensive auditing schemes that developed over the next two decades. This normalisation was achieved through the implementation of the KiwiGreen best practice scheme as part of the sector's response to complaints from the European market regarding 'pesticide residues' in fruit in the early 1990s. Thus, as a solution to the residue issue, compliance with the IPM protocols introduced the metrics of insect and disease counts as a whole of production chain responsibility.

3.2. The emergent character of metrics as a tool

The success of the IPM-related measures in re-establishing confidence in the quality of New Zealand kiwifruit provided the impetus for a broader and more strategic use of metrics within the sector that mirrored the emergence of “green” foods elsewhere (Lockie et al., 2000). Following the near collapse of the New Zealand production chain in the early 1990s, the sector was reorganised under the banner of ZESPRI the renamed NZ Kiwifruit Marketing Board which retained exclusive rights to export kiwifruit (with the exception of the Australian market). In addition to rebranding, the new entity began to engage in more focused market analysis that provided the impetus for the KiwiGreen scheme, a broader suite of quality criteria (with over 10 separate gradable measures with associated price premiums) and the introduction of the Gold kiwifruit (*Actinidia chinensis*). The KiwiGreen scheme became mandatory practice in 1995 and initially centred on the parameters for IPM. Subsequently, additional environmental, economic and hygiene measures were added and it was renamed the ZESPRI System in 2000. The continued predominance of metrics in the sector was hugely influenced by the emerging requirements of European supermarkets and food co-ops. The formation of the Euro-Retailers Working Group: Produce (EUREP) with the direct involvement of ZESPRI situated New Zealand kiwifruit at the centre of early negotiations of crop production protocols in the resulting EurepGAP standards for kiwifruit production (Campbell et al., 2006).

Not only did this create an initial level of legitimacy for the auditing scheme in New Zealand, but it also provided ZESPRI the leverage to negotiate reduced emphasis on criteria that elicited the most contestation and dissent from orchardists. As a result, what could easily be interpreted as an excessively detailed audit has been adopted within the sector with relatively limited objections (Rosin et al., 2007). It is also evident that such auditing has resulted in both greater awareness of environmental and social impacts of practice as well as improved outcomes while not negatively impacting the financial viability of the sector (Rosin et al., 2010; Campbell et al., 2012; Saunders et al., 2009).

The specific metrics that became embedded in this process included concrete measures for what were previously the subject of abstract scientific enquiry. Particularly, this involved the establishment of ‘thresholds’ for pesticide toxicity and dosage in alignment with the HACCP-based protocols of the EurepGAP audit alliance. In the hands of ZESPRI and EUREP, the metrics also became a tool for ensuring greater homogeneity across the supply chain, a characteristic that

ZESPRI has used to ensure price premiums for New Zealand growers. Eventually, the audit created the framework for elaboration of a number of new measures such as brix and dry matter levels (as indicators of taste). The end of this process was a shared set of measures, with fixed values, that were enabling multiple parties to participate in the same ordering of economic action.

3.3. Metrics and the Re-Ordering of economic worlds

Much of the success in the implementation of KiwiGreen derived from the relevance of its metrics across the whole of the production chain. The IPM protocols had been developed and verified by HortResearch scientists for whom the programme was a vindication of population ecology theory. For ZESPRI, the metrics provided a means to control and to communicate the limits inherent to that control. The marketing success associated with the practices strengthened the role of ZESPRI by reinforcing the value of its marketing knowledge to the orchardists. The kiwifruit packhouses were able to ensure the quality of fruit by maintaining the technical experts who assessed the severity of insect and disease threats reported by the orchard owners and managers who supplied them. The packhouses were, in this manner, able to regulate the ability to spray (again using newly fixed values and categories of 'safe' and 'unsafe' spraying). The shared acceptance of pest control based on metrics of projected damage calculated with reference to existing populations coupled with the successful revitalisation of the New Zealand kiwifruit sector established an environment within which metric-based management criteria became a normal element of production. The metrics at the heart of the KiwiGreen scheme thus established and coordinated action between multiple parties in the local industry and up the value chain.

Metrics also drove an associated set of developments at the level of orchard practice and grower activities. Beyond raising awareness of a broader suite of management criteria, the practice and reward of auditing was widely recognized in achievements such as increasing bird diversity on orchards and the positive interactions with non-kiwifruit growing neighbours. The emerging metric centric orientation of orcharding practice (what prior analysis described as a new 'spirit of farming' (Rosin, 2008)) had sufficient momentum to limit the impact of orchardists' concerns regarding the increasing oversight inherent to sustainability auditing. It also established a framework within which contractors providing both machinery and labour had no option but to comply with audit requirements on orchard management. This process was reinforced by the relatively positive economic outlook for the sector.

Whereas the selected metrics proved very capable of providing security of production and income despite economic and market volatility, they were eventually challenged by a threat to kiwifruit vine health. These challenges to the established metrics in the kiwifruit sector have emerged with the crisis surrounding the arrival of the PSA vine disease in 2010. The susceptibility of the vines to the disease has temporal correlation with practices (such as vine girdling) that supported the pursuit of specific fruit quality metrics (dry matter) by ‘stressing’ the vine. The emerging debate regarding the value of the girdling practices demonstrates the power of metrics in altering relationships between orchardists, their colleagues, their vines and the rest of the value chain.

In summary, the success of audit metrics in the kiwifruit sector is the product of their shared acceptance (relevance) across the value chain i.e., growers attained greater certainty through proven practices and positive feedback from local communities and markets; contractors were required to ‘up-skill’ but also received greater recognition of their importance to the sector; packhouses retained regulatory control over some on-orchard practice through spray assessments while also getting greater consistency in supply relationship with ZESPRI; ZESPRI was able to rely on consistent and higher quality production and also create a narrative of quality that sold in international markets; retailers had safe, high quality product; consumers found a responsive producer/supplier of desirable fruit with verified social and environmental practices. We argue that the new metrics are integral to the agency that both enabled new relationships and stabilised these resulting networks. In impelling such unexpected and uncontrolled change, they demonstrate a vitality for which social science explanations of audit practice must account.

4. Case study: wine

In the New Zealand wine sector, sustainability metrics first emerged as a tool rather than a set of measures (Flint and Golicic, 2009). Despite this distinction from the kiwifruit case study, the wine sector shows parallel development toward the acceptance of metric-centric regulation of practice as evidenced in the emergence of the Sustainable Winegrowing New Zealand (SWNZ) labelling scheme in 1995 (with commercial implementation in 1997) (Fairweather et al., 1999). SWNZ audit criteria expanded from an exclusive focus on vineyard practices to also include best practice criteria for wineries in 2002. Initial interest in metrics was driven by concerns regarding market access and positioning, especially in light of food safety scares in Europe and the revelation of the adulteration of Austrian wine with antifreeze in 1985. The sector looked to European best practice audits as a tool for verifying the quality of their wine which, as a relatively small player internationally, is highly dependent on its reputation. In the case of wine, the emphasis was, thus, on maintaining a premium

market position and proactively diverting environmental concerns from consumers in export markets (Gwynne 2006; Perry et al., 1997). Further notable distinctions from kiwifruit include the voluntary nature of the SWNZ scheme (although the fact that it is a requirement for participation in New Zealand Winegrowers events including the New Zealand Wine Awards helps to raise compliance to 94% of winegrowers and wineries) and the lack of a clear demonstration of its value adding capacity given the distinctive marketing relationships for wine. As a whole, however, the threatened loss of market access and the progress evident in the kiwifruit and horticulture sectors provided the rationale for the introduction of best practice metrics for wine (albeit without the same extent of crisis).

4.1. A metrology in search of metrics

Whereas the introduction of audited practice in the kiwifruit sector was predicated on the prior development of objective measures necessary for integrated pest control, the SWNZ scheme began with a firm conception of a mechanism that would help to coordinate production and lead to an export product of more consistent quality (Gabzdylova et al., 2009). As a result, the actual metrics reflect the shared elaboration of sustainability criteria within the wine commodity chain more generally rather than a response to a specific local crisis of the sort faced by New Zealand kiwifruit in the 1990s. For example, the International Wine Organisation (OIV, an intergovernmental organisation) and the International Federation of Wine and Spirits (FIVS, an industry interest group) have both identified sustainability as a key element for the viability of the wine sector.² The latter group produced the Global Wine Producers Environmental Sustainability Principles in 2006, parts of which were incorporated within the Guidelines for Sustainable Viticulture resolution adopted by OIV in 2008. The relevance of sustainability labelling for wine exports is further reinforced by the attention it garners within the World Wine Trading Group,³ which tracks schemes in seven countries in order to avoid the potential that these might emerge as trade barriers.

The objective of the SWNZ scheme is therefore to project a credible image of sustainable production without addressing a specific threat in terms of market access (Lewis et al., 2002; Prince and Lewis, 2013). In this light, it is not surprising that many of the metrics employed by the scheme have direct relevance to shared conceptions of good vineyard management (Hughey et al., 2005). For example, there is a strong emphasis on soil management an important practice for the

² fivs.org, Data reported on the organisations' webpages, www.oiv.int and www. respectively. Pages accessed 15 December, 2014.

³ From www.wwtg-gmcv.org. Accessed 15 December, 2014.

protection of soil physical and biological properties that is rationalized within the scheme on the basis of the ‘special relationship’ between the winegrower, the vines and the soil. Many of the specific soil measures comply with both commonly recognized environmental outcomes as well as the interests of winemakers (and wineries) in sourcing grapes from controlled yields. In this case, the New Zealand producers benefit from verifying their adherence to environmental practice while simultaneously incorporating the argument that the character of the grape is more fully realized when it is exposed to the ‘limitations’ of the soil and climate in terms of nutrient and water availability (what is frequently referred to as ‘terroir’). Further recommended practices extend these conceptions of soil management to more scientific measures of nutrient applications (and run-off potential), soil copper levels (for biodiversity implications) and undergrowth management. These latter metrics begin to shift the focus of vineyard management toward aspects that do not directly impact on grape quality or yield quantity.

Other metrics focus more specifically on the environmental expectations of consumers and the use of best practice in the sector. For example, the scheme imposes constraints on the application of chemical controls for disease and pests, the management of water and irrigation, the treatment of byproducts, impacts on the atmosphere and energy use (Hughey et al., 2005). In each of these cases, the position of SWNZ is that they involve necessary aspects of wine production and the focus of the scheme is on greater efficiencies. The point of these measures is to demonstrate positive trends towards the rational use of inputs and to communicate a narrative of environmental stewardship to concerned consumers. These metrics create an environment in which relative usage and application become targets of practice and lead, in some cases, to contestation of their ‘fairness’ in comparative situations. For example, Hawkes Bay vineyards are faced with more pest and disease friendly climates and, thus, have generally higher chemical application rates. Similarly, energy use is likely to be higher for regions requiring higher levels of frost protection.

Energy and water use have received more focused attention within the scheme. This is, in part, a reflection of the relative ease of measurement of these inputs which already have metered flows, especially within wineries. The advantages of more efficient use of such inputs were also already apparent to participants; and the ability to benchmark practice relative to the reporting of a majority of colleagues allowed many to achieve cost savings. Finally, efficiencies achieved in terms of such inputs provided cost savings for producers and winemakers.

4.2. Re-ordering of economic worlds?

Despite the obvious parallels between the impact of the respective sustainability audit schemes in the kiwifruit and wine sectors, the SWNZ metrics do not appear to establish the same level of coordination of the sector's economic worlds. This conclusion by no means suggests that metrics are not enactive in organizing wine worlds given that a major influence on the implementation of metrics in the wine sector involves consumer expectations regarding the quality of wine and their ability to distinguish between producers. In comparison to kiwifruit, which is largely differentiated by size, shape and firmness at the point of consumption, the wine from an individual winery can be distinguished by branding and is subject to the taste preferences of the consumer. As such, the value of an audit based on practice can be considered secondary to the marketing of a wine label. Evidence of the secondary nature of sustainability labelling is found in the inconsistent use of the SWNZ logo by registered winemakers.

A frequently more prominent feature of labelling involves reference to recognised assessors of the taste qualities of a wine. The selling of wine is promoted to a great extent by recognition of its quality among experts who rate the quality of wine according to preferred tasting profiles. This process occurs either through participation in wine judging competitions or in the tasting notes of noted wine tasters, which are often translated into metrics that are deployed at the point of sale. The most notable competitions in New Zealand are the Air New Zealand Wine Awards and the Bragato Wine Awards, but New Zealand wineries will participate in international wine shows as well in order to establish 'verified' recognition of quality. An important means of increasing sales is to garner a good review from the likes of Oz Clark (in the UK) or Robert Parker (in the US). Such expert evaluators have a strong influence on preferences in markets and their metrics become sites of coordination across multiple nodes of global wine economies. The power of these metrics is especially important for emerging wineries or varietals that lack the brand recognition to generate sales. In several cases in New Zealand, market breakthrough overseas came with the awarding of a '90p' Parker score.

A further limitation to the re-ordering capacity of metrics relates to the more individualized access to markets for winemakers. The wine sector has no direct equivalent to ZESPRI as a single desk exporter, with the New Zealand Wine Institute acting predominantly to market the New Zealand brand and set quality standards for export. In this context, wineries will be the primary agents for marketing wines to international distributors. Given such dispersed negotiations, it is difficult to establish the added value of SWNZ certification and, even more so, to translate this into terms that are relevant to the growers and contractors who supply the wineries. The extent to which the

metrics are used to integrate economic worlds depends, thus, on whether a given winery perceives that making sustainability claims is an essential element of their marketing narrative. In fact, wineries who are less inclined to refer to SWNZ certification in their marketing often portray their compliance as a proactive effort to divert potential strategic challenges to their brand integrity from competitors.

Despite such limitations, many participants consider the SWNZ accreditation program to still be important because of its ability to facilitate communication and sharing of knowledge in the sector. SWNZ acts as a common interest group for the sector and is expected to represent the interests of those for whom the reputation associated with product safety and environmental practice is important. Reporting based on the accreditation surveys also allows for benchmarking of practice, a feature which is frequently noted as providing the means to improve both enterprise and sector standards.

The agency of metrics in the New Zealand wine sector is apparent in their capacity to extend influence beyond the anticipated rationalisation and homogenisation of production and winemaking practices. The participation of metrics within the wine commodity chain also involves a reorganisation of relationships between winemakers and consumers (and by extension exporters, wholesalers and retailers) with the potential to exert greater control over the production of grapes supplied by contract growers. Because sustainability metrics are more directly linked to internal vineyard management, they enable greater scrutiny of practice and establish the basis for verifying compliance throughout the chain. It is the variable capacity of metrics to illuminate aspects of winegrowing and winemaking practice that determines the points of linkage among actors (e.g., soil qualities and energy use) as well as those that remain relatively obscured (e.g., labour practices). The result is a more fully integrated production chain, although it still lacks the level of cohesion evident in the kiwifruit sector.

5. Case study: indigenous branding

To this point, we have discussed case studies in which the novelty of the introduction of sustainability metrics involved the expansion of existing cultural practices (i.e., the acknowledgement of economic and science-based logics of best practice) to new aspects of commodity production (i.e., environmental sustainability). However, the apparently beneficial contributions of metrics as agents to the economic viability of economic practice (both in New Zealand and internationally) has also promoted their participation within culturally distinctive

contexts, namely as a means to translate and eventually integrate Western market conceptualisations of sustainable practice within Maori economic development. This suggests that, in the case of indigenous branding, the agency of metrics was already in evidence prior to their overt use as measures or tools within Maori production frameworks and that a desire to engage with the potential agency of metrics was a driving motivation behind their deployment by different groups and institutions.

5.1. Engaging with re-ordered economic worlds

The unique cultural context of the emerging set of metrics inherent to the development of indigenous sustainability reporting systems within Maori tribal authorities provides an insightful contrast to the kiwifruit and wine sectors. To understand this indigenous approach to auditing, it is necessary to explain the drivers, motivation, and context underpinning its development a narrative that starts with Ngai Tahu, one of New Zealand's largest Maori tribes. Following the settlement of Treaty of Waitangi⁴ grievances with the New Zealand government in 1996, Ngai Tahu used the financial compensation they received to establish a number of successful tribal enterprises in the forestry, farming, fishing, and tourism sectors under the umbrella of its corporate body, Ngai Tahu Development Corporation. To date, Ngai Tahu has grown its asset base from NZ\$178 million in 1998 to NZ\$880 million in 2013, while distributing NZ\$280 million in development funds to its communities. Similar success has been realised by other post settlement tribes, giving rise to the term 'taniwha economy'⁵ to refer to the rapidly growing tribal business sector (Sharples, 2012).

This economic success also raises challenges, both external and internal to Ngai Tahu, related to the sustainability of the enterprises involved. After many years of fighting 'rear guard' actions against the New Zealand government in pursuit of social justice and greater environmental protections, Ngai Tahu and other tribes are finding ways to align their emerging business and political interests with their environmental ethics and worldview (Reid and Rout, 2016). In fact, in order to maintain credibility, the high environmental and social standards that tribes once demanded of those in positions of power are now the default standards by which tribes must abide

⁴ Initially signed as a document of governance between colonisers and Maori in 1840, the Treaty of Waitangi re-emerged in the latter part of the 20th Century as a legal and political initiative around which longstanding grievances arising from colonial dispossession of Maori tribes could be addressed.

⁵ A taniwha is the Maori term for what would possibly be translated as a monster or dragon, and in the Maori usage, the term conveys both threat and potential power. Thus, the Taniwha Economy is an unrecognised source of economic power that may be big and have unexpectedly large influence.

in their own business activities (Reid et al., 2013). The tribal authorities are aware of the growing demands for sustainable products from discerning consumers internationally and the premiums such consumers are willing to pay for products displaying indigenous branding. Furthermore, they are cognizant of the increasing sustainability standards under development in the areas of food and fibre production. Consequently, there is recognition of the risks to their business of losing quality markets by failing to keep in step with the capacity of metrics to develop standards, as well as to order the economic worlds of the premium markets demanding products that are both indigenous and sustainable.

In addition, Ngai Tahu and other tribes find themselves in the somewhat atypical arrangement of having their assets consolidated within tribal corporations. Tribal members are elected to a council to act as trustees over corporations, protecting and growing tribal assets for the benefit of current and future generations. This arrangement is in stark contrast to traditional configurations in which rights and governance are within the domain of the extended family and sub-tribe. As a result, a degree of political tension exists between the central governors and managers of assets and their beneficiaries, the latter ultimately perceiving that their tribal corporations control what should be an asset of their family or sub-tribe (Barr and Reid, 2014). Consequently, pressure is placed upon tribal governors to assure constituents that assets are being managed responsibly and capably. In addition, tribal entities struggle to populate their commercial bodies with tribal members due to shortages in technical capabilities within their communities. As a consequence, these commercial entities are primarily managed by 'outsiders,' which creates some tension between governors and management. In particular, there are concerns of management 'takeover' and the failure of corporate arms to comply with the cultural and environmental values of their tribal parents.

5.2. Metrics as a tool to communicate and translate

It is in this context that sustainability reporting systems assume an integral role in the development of indigenous production frameworks. It is imperative that Ngai Tahu and other tribal authorities meet cultural and environmental, as well as economic, expectations. Tribal governors are under increasing pressure to communicate, and provide assurance, that their assets are being responsibly managed in terms of these imperatives. Furthermore, governors desire assurance that their own management personnel are behaving in a manner that complies with cultural values. Consequently, the need for some sort of auditing and reporting system has become obvious to tribal governors: first as a means of assessing and encouraging improved sustainability performance of their

corporate entities; and second, as a mechanism for reporting on that performance to both governance and tribal members.

This is particularly challenging given that tribal corporate interests are heavily involved in the primary sectors of farming, fisheries, and forestry, all of which are increasingly exposed to environmental scrutiny. A recent large-scale conversion of forest lands to dairy farms by Ngai Tahu has received significant media attention expressing concern over the ecological impacts of dairying on water quality.⁶⁶ This concern also exists within the tribe itself, as the negative effects of intensive dairying on streams and rivers threatens traditional Ngai Tahu hunting and gathering da cornerstone of Ngai Tahu culture.⁷ Consequently, there is emerging tension between the economic imperatives of the tribe driven from its commercial operations and its cultural and environmental imperatives, driven from its grass-roots families and communities.

Ngai Tahu is also aware of consumer interest in products that have unique indigenous stories behind them (Barr and Reid, 2014; Reid and Rout, 2016). This led to the development of two indigenous branding initiatives by Ngai Tahu to test market interest for such products: Ngai Tahu Pounamu; and Ahika Kai. Ngai Tahu Pounamu is a business focused on producing traditional jade jewellery, while Ahika Kai is a business offering traditional wild foods. Both have the same approach to marketing products based on indigenous authenticity, sustainability, and traceability. Despite each initiative having realised commercial success, there has to date been a lack of any formal reporting systems to assure consumers of the actual sustainability of their business practices.

5.3. Selecting and operationalising metrics

In response to these drivers for sustainability verification, Ngai Tahu in collaboration with other leading tribes has developed a reporting system, referred to as Te Pataka Matauraka Putaiao (PMP). The predominant effort in this process involves the identification of indicators and assessment criteria that adequately account for the measurement concerns of consumers and regulators while also conforming to Maori cultural expectations and ethical demands. This compromise is achieved by selecting metrics that track recognised measures of sustainability, while also assessing these in terms of process and trajectory. The intent of this strategy is to provide flexibility in terms of

⁶⁶ Alan Wood, 'Ngai Tahu drive for \$1.5b farming assets' The Press, 02/04/2014; 3 News, 'Ngai Tahu eyes 'sustainable' dairy farming' 3 News, 6 Jan 2011; Hamish McNeilly., 'Big Dairy Plans for Ngai Tahu' Otago Daily Times, 6 Jan 2011.

⁷⁷ Te Karaka, 'Mana whenua approve pilot dairy farms', Sept 15 2013 (Te Runanga o Ngai Tahu).

incorporating external measures (compatible to western capitalist business practice) within a culturally acceptable tool.

The PMP includes the development of an online dashboard to support sustainability self-auditing for Maori tribal enterprises in forestry, fishing and farming. In regards to metrics, PMP can be contrasted to the kiwifruit and wine case studies in several aspects. The focus of the system is not on single output measures (e.g. yield, water quality, or dry matter), but on the metrics of behavioural change within tribal organizations and businesses. This approach reflects the tribal institutions' need for practical tools to assess the compliance of business practices with indigenous values as demanded by tribal communities and their governors. The result is an audit system focussed on learning and capability building with the intention to drive positive behavioural change, which (it is anticipated) will correspond with positive changes in system output. Consequently, rather than using output measures to drive behavioural change, behavioural change (in line with values) is primarily the focus.

Overall the indigenous sustainability audit system assesses hundreds of practices, across different parts of tribal organizations and businesses, to verify the extent to which (using numerical metrics) these comply, or are in line with indigenous values and ethics. The focus is not on an overall measure of practice-based performance, but on representing the richness and diversity of behaviours required for compliance. The intent is to reduce 'gaming behaviours' designed to raise single measures of performance and provide a more nuanced understanding of the organisation's complexity. Reliance on self-assessment remains a limitation of the system making it liable to manipulation by those reporting on their own practice. Nonetheless, the result of the assessment is an automated report that details the practices that can improve sustainability performance, with links to resources to assist in this learning process. In this manner a deficit reporting approach is avoided, in favour of a continual improvement process as a means of mitigating the limitations of self-assessments.

The PMP aligns with many international sustainability assessments in terms of being practice-based (e.g. organics, the UN-FAO sponsored Sustainability Assessment of Food and Agriculture, etc.); however, it introduces novel responses to the challenges of growing consumer and regulatory expectations of science validated 'hard' sustainability measures expectations that are in conflict with an indigenous approach centred on values-guided practices that encourage reflexive learning and continual adaptation. In this manner, hard metrics are used to complement practice based

assessments, allowing the causal relationships between practice and outcome to be better understood. In fact, such a process could well improve reflexivity and adaptation. It is also clear that many tribal businesses, particularly at family and subtribe scales, have neither the capability nor the financial means to undertake detailed measuring and monitoring of outputs. Consequently, the drive toward hard measures by markets and regulators has the potential to exclude small and medium sized enterprises that cannot afford compliance burdens. These dynamics reveal not only the capacity of metrics (as agents) to structure and organise the articulation of indigenous and western social forms, but also the degree of reflexivity in the relationship between human and nonhuman actors. It is also apparent in this case that metrics are tools used by actors both to legitimise their leadership within their cultural context as well as to discipline financial managers from outside that context. And, finally, the third aspect of metrics (as inert measures) is evident in the process of selection during which the relevance of proposed measures are evaluated on the basis of what is measured and the perceived accuracy of that measurement.

6. Discussion

The role of metrics in the New Zealand case studies examined in this article (and their increasing appearance in scholarly literature) suggest that they are becoming an integral feature of contemporary networks of production, especially in the primary sector. In so far as metrics may be enrolled within these networks as simple representations of a product's quality, their impact extends well beyond the intended or anticipated. By introducing a novel basis for valuing products, practices and actors, metrics also contribute to the emergent ordering of production as a social process. As with all forms of coordination, the long term impact involves not only a heightened certainty of production outcomes, but also the potential to constrain flexibility or limit resilience by narrowing focus on the measurable and the accountable. Thus, through their ability to control and create value, metrics are often manipulated as tools to benefit more powerful interests. Yet, the case studies also point to an uncontrolled, unintended and unexpected vitality of metrics that imbues them with their own agency in the evolving social and economic worlds of primary production.

The kiwifruit case study is a clear demonstration of the enactive potential of a more metric-centred set of production practices. The initial introduction of pragmatic measures to verify the acceptable levels of pesticide residue on fruit and associated metrics of pest management on orchards facilitated the eventual expansion to a more comprehensive set of practice and outcome metrics oriented to perceived consumer demands. The economic success associated with such metrics has

reinforced the legitimacy of both further metrics and the social and hierarchical relations within the commodity chain and, thus, enabled their strategic use as a tool to coordinate and homogenise fruit characteristics. The emphasis on consumer perceptions and demands has, however, arguably constrained the capacity of the sector to respond to other pressures such as climatic variability and pest incursion. As new forms of metrics are introduced in response to the PSA outbreak, the vital agency of metrics is again apparent in the resultant shifts in the relationships between ZESPRI, packhouses, kiwifruit growers, labourers, and agricultural input suppliers.

The development of the SWNZ audit and labelling scheme shows the potential for the strategic introduction of metrics as a tool for collaborative positioning of wines in higher priced niches in international markets. The success of such a scheme remains dependent, however, on the pragmatic capacities of measures to verify product characteristics in export markets. The SWNZ case study shows that the result is a negotiated set of measures that represent what is readily measured (and informs aspects of efficiency and production on vineyards and in wineries) as well as more challenging metrics of importance to targeted markets. The efforts to homogenise production practices around shared qualities has also altered the governance of the sector and the subjectivities of individual growers and producers, exposing the agency of the selected metrics. Despite the strongly individualized and independent nature of winemaking (including the recognition of quality in wine competitions or by renowned tasting experts), compliance with the SWNZ audit involves a collective enterprise to gain recognition for New Zealand wine as a whole. In the process, participants in the sector must willingly submit to control and to the oversight that facilitates benchmarking and diminishes the mystery of winemaking and terroir.

The emergence of best practice auditing in Maori enterprises is, at its basis, an example of the agency of metrics. The quintessential point is that Ngai Tahu economic development managers deliberately sought out metrics for their audits in clear recognition that these have transformative agency. What happens with these metrics are not unintended consequences, it is the direct result of political and economic choices. The agency of metrics to enrol and reorder is so useful for Ngai Tahu precisely because they are situated as a key node in networks of economic activity (or in the aspiration to create networks of activity) and, in some ways, face in two directions simultaneously. In one direction lies the market, where measures of sustainable activity in the production of indigenous products (verified by Ngai Tahu) create a legitimate semiotics of product quality that can be understood by consumers. In the other direction are the members of the tribe and their smallscale enterprises. At this level, systems based evaluations of cultural practice within

sustainable production and manufacture of indigenous products can operate according to cultural values or a consensus around what is appropriate practice. Conversion of these into metrics provides a means to translate these activities to wider market networks. The metrics both translate and discipline indigenous production practices. They point (and translate) inwards as well as outwards, a quality that makes them particularly attractive to tribal managers.

The case studies summarized in this article illustrate three modes of action attributable to metrics within actor networks: pragmatic (in terms of measures or representations), strategic (in terms of tools to organize or coordinate actions of other actors) and vital (in terms of an independent agency). The pragmatic and strategic actions of metrics conform to the aspects of metrics that are most commonly addressed in the literature on sustainable practice, namely as indicators used to verify outcomes of applied best practice and as elements of industry programs intended to promote and enforce consistency of practice across suppliers. The vital actions of metrics, identified in the case studies as the unintended (and unexpected) alterations of social and environmental relations, are less commonly addressed in the literature, but are nonetheless strongly evident. Furthermore, the comparative analysis demonstrates that, despite the distinct manner through which metrics initially participate in each network, metrics escape their intended roles and engage with other actors via all three facets of action. Thus, no matter the context, metrics do measure, they do organize and coordinate, and they do re-organize according to their own capacity.

7. Conclusion

The analysis of the New Zealand case studies also has broader theoretical implications that reflect the three aspects of metrics which we have highlighted. In the first instance, the analysis demonstrates the potential insight to be derived from an awareness of the agency of metrics. The reorganisation of the social ecological networks do not rigidly follow the narratives suggested by political economic or less critical approaches. In other words, the enrolment of metrics in these networks elicits unintended and unexpected change that cannot be attributed directly and solely to human agency, let alone to structural power relations. Rather they enact changes to the conditions within which humans and politics operate.

In addition to highlighting the vital agency of metrics, our analysis also indicates the need for continued awareness of the role of metrics as tools and as measures. While not wholly determinant, power relations remain important factors in the emergent character of each of the case studies. A more critical political economic analysis would undoubtedly expose greater detail of the extent to which the introduction of sustainability audits is used as a tool to direct and control the actions of

less powerful actors. Similarly, a more detailed critique of the accuracy and legitimacy of selected measures would raise issues regarding the extent to which sustainability is likely to be achieved.

Our intent in presenting the case studies is not to adjudicate as to the relative value of different theoretical approaches. Rather, we wish to demonstrate the value of increased academic attention to and awareness of the agency of metrics in helping to better understand the social ecological dynamics of the production systems within which they operate. Such recognition of the unexpected and uncontrollable influence of metrics, we argue, opens spaces and vacuums within which traditional forms of power may not necessarily be realised thus exposing weaknesses that can be exploited in the pursuit of more just and equitable economies.

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