# Māori livestock farming achieving functional integrity?

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***Keywords***

Maori, land use, decision making, sustainable land management, New Zealand

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***Summary***

This paper uses a historical analysis of agricultural development to explore functional integrity of the New Zealand rural landscape arising from a national agenda to pursue greater agricultural outputs. The concept of functional integrity is extended by Māori farming as it introduces a further set of functions related to the aspirations of indigenous landholders. A land-use integrated decision-making framework (IDMF) was developed and applied to four Māori farm case studies that wanted to use land performance to meet their aspirational goals. The IDMF has linked indigenous knowledge with Western science and industry knowledge to form a holistic framework for framing questions, and evaluating and designing land-use options that have the potential to balance multiple outcomes and confer functional integrity. The IDMF provides a framework that will organise multiple activities and coordinate different quantitative and qualitative data sets in a visual format that allows for discussion within a collective decision-making environment. The framework was found to be useful for exploring and making transparent the trade-off between differing functions. This understanding guides the exploration of strategies that will enable the attainment of several functions simultaneously.

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## ■ INTRODUCTION

The functional integrity view is an approach suggested by Thompson (1997) to analyse sustainability. It views agriculture as a complex system of production practices, social values and ecological relations; the functional integrity of which may be nurtured or disrupted by human practice. The other approach suggested by Thompson is resource sufficiency, which maintains an outside point of view, the viewpoint of the observer. Functional integrity, conversely, acknowledges an inside point of view or the viewpoint of the player, acting in accordance with certain goals (Alroe et al., 1999). Functional integrity is a dynamic concept that changes depending on the observer's worldview. This paper uses a historical analysis of agricultural development to explore functional integrity of the New Zealand rural landscape arising from a national agenda to pursue greater agricultural outputs. The concept of functional integrity is extended by Māori farming as it introduces a further set of functions related to the aspirations of indigenous landholders. Comparing these two perspectives enables an exploration of the means of achieving a wider set of landscape functions. This in turn identifies lessons to enhance the functional integrity of Western livestock systems. The paper structure addresses: i) the history of New Zealand's rural transformation driven by the economic imperative – this section explores the dilemma facing local development through livestock farming and characterises cooperative arrangements; ii) an analysis of Māori case farm studies is described and our discussion has a focus on the development and application of an integrated decision-making framework to achieve functional integrity; and iii) some questions at the end for further research.

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## ■ HISTORY

By 1840 the total forested area of New Zealand had been reduced from 85% of the land cover to about 53% (14.3 million hectares) (Ministry for the Environment, 1997). From 1860 onwards there was a rapid increase in the European population seeking to purchase and clear land for farms for development. The resulting impact saw a rapid increase in the area of land in pasture: from less than 70,000 hectares before 1861, to 1.4 million hectares in 1881 and 4.5 million hectares in 1901. From 1890 to 1900, 27% of New Zealand's indigenous forest land was cleared and the number of farms increased eight fold from 10,000 to 80,000 by 1921 when the total occupied area reached its maximum limit of 17.6 million hectares (Ministry for the Environment, 1997). The introduction of the Native Land Act in 1862 saw a rapid increase in European landownership as land previously held by families and clans was traded and at times confiscated under legislation such as the Land Settlements Act in 1863. By the early 1900's over 80% of Māori land was alienated. The current area under collective Māori ownership is less than 5% (Kawharu, 1977).

During the 1960's the government considered that an improvement in export earnings was necessary for long term economic growth. Given the fact that all of the potentially useable land was in farms, it was recognised that to increase export earnings from agriculture, there was a requirement to intensify through use of technology, and that incentives would be required to farmers for them to raise investment levels and create an environment for agricultural expansion. The resulting 1963 budget had three incentives: loans for development, subsidies on fertiliser, and tax write-offs for capital expenditure associated with development. Research and the adoption of technology were seen to be the key to success as a nation. Emphasis was placed on improving soil fertility, introducing improved genetics to plants and animals, improving animal health and optimising farm systems. In parallel with research and development there was the deployment of an agricultural extension service to teach farmers how to implement the new technologies. This protectionism continued into the 1970's and early 80's to retain the prosperity of the 50's and buffer negative external forces such as oil prices. By the mid-1980's the non-sustainability of support was recognised and a major adjustment in New Zealand farming from the removal of incentives and subsidies and the privatisation of the extension service occurred.

## ■ DILEMMA

Until the 1990's, therefore, New Zealand agriculture was dominated by an economic production imperative with farm practices directed at controlling the inherent system variability and manipulating the inputs to retain states that maximised food and fibre production. During the1990's there was a realisation, substantially driven from the community level, that the pursuit of production goals had compromised other resources for human well-being, e.g. water quality and biodiversity. This has led to land managers now having to take into consideration the relationship between managing for production gains and providing outcomes more commonly aligned to the public good. Of importance to New Zealand is also the cultural values held by Māori. Cultural values shape the way Māori think about issues, form the basis for decision making, and are fundamental for establishing aspirations, desires, and priorities (Marsden, 1975; Marsden and Henare, 1992). Traditional concepts and beliefs still resonate strongly within contemporary Māori society. Cultural values therefore reflect both the long history and relationship Tangata Whenua (people of the land) have with a given area, location, catchment, or region and their world view, strongly influencing land-use decisions.

Although the major driver acting to focus on farm functions other than production is local and cultural, international markets are also important to New Zealand. This illustrates that issues are connected in time and space with interactions across scales, global to paddock. Food security, water use, climate change, biodiversity loss, economic well-being and social equity and justice are therefore all tied together in pastoral livestock agriculture.

Today, as a developed country New Zealand has a unique profile in having a high dependency on the agricultural industry for its economic well-being. In the year to November 2010 agriculture made up 44% of merchandise exports which totalled $43.1 billion (Statistics New Zealand, 2010). In 2005 New Zealand's total land of 26.9 million hectares comprised 11.7 million hectares (43.5%) in sheep, beef and dairy farming (Statistics New Zealand, 2005). Of this, 1.5 million hectares were in collective Māori ownership with over $1 billion annually generated from the primary industry sectors.

The dilemma that faces New Zealand's society is therefore how to maintain ecological integrity of the resources that underpin agriculture and adjacent ecosystems, while adding value to local and national economic, social and cultural well-being, and delivering ethical goods to international markets. Māori land management provides fertile ground to explore how the twin imperatives of economic development and functional integrity can be balanced.

## ■ COLLECTIVE ARRANGEMENTS: GLOBAL EMBEDDED IN LOCAL

The cooperative nature of New Zealand's farming industry and Māori landownership offers an opportunity to address the dilemma through balancing functional integrity. Cooperative institutional structures characterise livestock farming in New Zealand with about 95% of dairy production processed and marketed using this type of ownership system. Farmers are also shareholders in fertiliser processing cooperatives and in some instances meat companies. These arrangements mean that individual farmers not only influence local development through their land-use choice and management decisions but also have a direct influence on global provision and thus development.

Māori land today is administered under the Te Ture Whenua Māori Act 1993 and is predominantly under multiple ownership (where there are multiple owners registered against the Certificates of Title). There are approximately 26,480 titles with an average of 73 owners per title and the size of these titles range from 800 $m^2$ to 500 hectares. Around 70% of Māori land is administered under a trust or incorporation structure. Many of these organisations have achieved strong viable farm businesses through the consolidation of land and the separation of the business from the provision of social and cultural services. A key characteristic of Māori land is that although the average area per title is around 50 hectares, 50% of these titles are less than 3 hectares and 70% less than 11 hectares resulting in a large number of blocks with small areas of land; many are uneconomic to be farmed on their own. Of the 5,000 trusts (Ahuwhenua Trust) the majority manage less than 5 hectares. Additionally, while there are over 5,000 trusts and 129 incorporations, 40 incorporations control 80% of incorporation land and 100 trusts control around 60% of trust lands (Kingi, 2008; Kingi, 2009a; Kingi, 2009b). This data suggests that there are two distinct groups emerging in Māori land: A small number of large blocks and a large number of small, often uneconomic blocks of land.

While many of these uneconomic land blocks are too small to be run as a viable business, they also lack management infrastructure and skilled personnel. Often farms attempt to service business, social and cultural goals together. Again there is a strong link to local development and community well-being through the flow-on effects of farming and also the strengthening of family ties through *whakapapa* (genealogy) where members of a family will be owners in more than one property.

As agriculture is embedded within local communities the functions acknowledged and managed for will be influenced both by local perspectives and needs, and global viewpoints. The huge contribution from livestock farming is therefore based on socio-ecological systems that include human behaviours co-evolving with ecosystem properties to sustain a particular set of functions. Collective management of farms influences the final decisions taken and emphasises the importance of having a framework to guide decision making that takes into account the multiple functions different stakeholders expect from the land.

## ■ CASE STUDIES AND METHODOLOGY

We have selected case studies with Māori farms that were all located on the east coast of the North Island of New Zealand. They had as their aim to improve performance from their land to enhance their aspirations. We used these cases to develop and apply a land-use integrated decision-making framework (IDMF) (Figure 1). This was an attempt to integrate socio-cultural imperatives with comprehensive land-resource assessments, complex simulation modelling and a deliberative process to allow future land-use options to be assessed against a range of functions identified by landowners.

### *Case of Ruawaipu*

Ruawaipu is a collective of five Māori multiple-owned farms located between Te Araroa and Ruatoria. All farms run sheep and beef breeding enterprises. Farm size ranges from a total land area of 2,000–3,000 hectares with effective grazing of around 2,300 ha. Total shareholders and beneficiaries exceed 1,000. All farms are governed under the Ahuwhenua Trust structure committee of trustees.

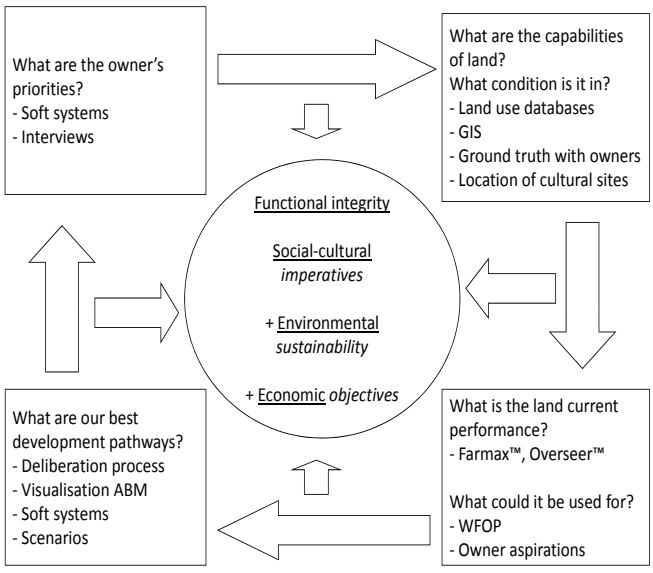


***Figure 1:*** *Integrated decision-making framework (IDMF) for delivering functional integrity.*

### *Case of Ngati Hine*

The research team engaged with the Ngati Hine health trust on 18,500 hectares of the Ngati Hine Rohe Whenua (tribal region), north of Whangarei, Northland. Their project "Taunaha" is a flagship Māori cultural wellness model combining elements of cultural, social, and environmental aspirations to advance the lives of Ngati Hine people through their connection to the land. Ngati Hine's translation of functional integrity is "*taonga tuku ihoa, nga korero tuku, ihoa*" with Tikanga providing the guidance and policy for implementation. Project Taunaha's paradigm of thinking is around *oranga* (wellness) and *orangatanga* (well-being). Wellness is about the physical condition of a resource or person, the *tinana* (body), and well-being is the natural condition of a resource or person i.e. the spirituality (spirit) and *hinengaro* (soul) (Tipene, 2010).

### *Case of Waimarama Inc.*

Waimarama is one of three Māori incorporations located on ecologically fragile, but highly sought after coastal land, around Waimarama in Hawkes Bay. The incorporation (approximately 2,000 hectares in size) aims to expand its land base through leases with neighbouring blocks and has identified alternative land-use options that will diversify their production base away from the pastoral sector.

### *Case of Aohanga Inc.*

Aohanga farm covers approximately 6,818 hectares of which about 3,039 hectares are used for sheep and beef production. Aohanga, Waimarama and Ruawaipu face increased frequency of summer droughts. Building resilience into their land use to cope with this was for them a key driver.

### *Methodology*

A systems perspective was applied in all case studies to make transparent the relationships between people, natural resources, economics and culture. Interviews were conducted with individual members of the case study organisations to document *matauranga* Māori (indigenous knowledge) about the land and its owners. Workshops using soft system methodologies were held with members of the farm committees to identify their aspirations for the land (Wedderburn et al., 2004a; 2004b; Kingi et al., 2010a). A full description of the underlying soil, vegetation, water and indigenous cultural sites was developed for each of the properties using on ground surveys, land manager experience, land-use databases and historical data (Harmsworth and MacKay, 2010). All the data was placed into a geographic information system (GIS) database. An analysis of the current performance of the farm productive and environmental outcomes was undertaken using Farmax$^{TM}$ and Overseer$^{TM}$ models (King et al., 2010). Farmax is a computer simulation model that allows individual farms to be modelled and enables a wide range of "what if" scenarios to be explored. The programme matches pasture growth data with a livestock system to optimise profit. Overseer models the nutrient balance of a farming system and produces outputs related to environmental emissions (e.g. nitrogen, phosphate, nitrous oxide and carbon equivalents).

Some tools and methods were developed for specific case studies: A whole farm risk optimisation model (WFROP) was applied to Aohanga to assist in the evaluation of land-use options that met their farm objectives and preferences to design feasible farm plans (2). The model generated information that allowed the owners to identify the trade-offs between achievement of different objectives i.e. maximise gross margin while minimising environmental

impacts, e.g. nitrogen leached and greenhouse gas (GHG) emissions. An agent-based model (ABM) linked to a GIS visualisation tool was developed for application to the Waimarama catchment to show the impact on land use when properties network to achieve a range of outcomes (Kingi et al., 2010a). At Ruawaipu the land-use goals had their feasibility tested by researchers and regional advisors evaluating options on key success factors associated with land capability, existing infrastructure and human capital (Wedderburn et al., 2004a; 2004b). All of the information generated through the interviews, workshops, field work and modelling was used to develop a holistic integrated framework that could form the core of a deliberation process. The process was designed to enable alternative future land-use options to be assessed and choices made that take into account and make transparent the trade-offs between different functions.

## ■ RESULTS

Analysis of the system workshops were collated into the aspirational themes of the owners. Owners used the resource inventory maps and the model outputs to improve their understanding of the state of their current systems before exploring new options and undertaking a deliberation process. These activities tested and addressed the questions posed in the IDMF (Figure 1).

### *Aspirations*

Table I notes the aspirations (functions) that were identified from the workshops held with landowners across the different case studies. The aspirations were formed into functional themes related to natural characteristics, indigenous sites, business viability, land

**Table I**

Deliberation framework to assess the impact of future land-use options against the functions identified through aspirations and goals of case-study Māori landowners in New Zealand

| **Aspirations: functions (achieving these would confer functional integrity)** | **Future land-use option** | | | | |
|---|---|---|---|---|---|
| | **Cultural Tourism** | ***Papakainanga* (family housing)** | **Olives** | **Biodiversity conservation management** | **Forestry** |
| **Economic** | | | | | |
| Providing an income | √ | | | | |
| Self-sustaining community | | | | | |
| Diversity of farm base | √ | × | √ | | √ |
| Economic viability | | × | | | √ |
| Existing market | √ | | √ | | √ |
| Land in safe hands for future generations | | | | | |
| To reconnect our people with the land | √ | | | | |
| **Cultural** | | | | | |
| Kaitiaki | | | | | |
| Turanga Wae Wae | | | | | |
| Tino Rangatiratanga | | | | | |
| Mana Whenua | | | | | |
| Heritage | √ | × | × | | |
| Improved cultural identity | √ | | | | |
| **Social** | | | | | |
| Knowledgeable and skilled people | | | | | |
| Grow *whanau* opportunities | √ | √ | √ | | |
| Good governance | | | | | |
| Integral part of wider community | √ | √ | √ | √ | |
| Collaboration between landowners | √ | | | | |
| **Environmental** | | | | | |
| Land-use capability | | | √ | √ | √ |
| Protect and preserve environment | √ | | | | |
| No erosion | | | | | √ |
| Clean water | | | | | √ |
| Biodiversity | | | | | |
| Reduced greenhouse gas emission | | | | | √ |

×: Land use is not suitable to achieve that function.
√: Land use will contribute to achieve this function.

retention in perpetuity, *whanau* (extended family relationships) and cultural well-being. The aspirations were incorporated into the deliberation process of the IDMF ensuring the goals and values of the Trust were included in the assessment of future land-use options.

## *Understanding your current system*

In all instances the Māori landowners were keen to understand the current performance of their existing production systems, how they compared against industry standards and how they could make improvements. For example outputs generated from Farmax and Overseer for Aohanga showed that the current farm system was already well configured for the land resource, and that emphasis should be placed on mainstream livestock activities with an emphasis on further subdivision and water supply. In the case of Waimarama a change in enterprise plus implementing a programme of cost-saving management actions could support existing debt and improve farm profit significantly. The relationship between farm profitability and the ability to run a cultural tourism enterprise and connect with local development was identified through the development of a causal loop diagram outlining the relationships between the factors conferring success to the landowners (Figure 2). Alternative strategies that were explored were the amalgamation of production with other neighbouring Māori land blocks or leasing the land to meet debt and improve profitability. This information was used to guide the decision to employ a farm consultant and to explore networking with other land blocks to confer resilience to the impact of increasing frequency of summer dry conditions that were having a deleterious impact on their farm viability. For both Aohanga and Waimarama the low intensity of the livestock systems meant that the farm systems had a low environmental footprint.

## *Exploring future land-use options*

Land-use options were identified by the different case organisations based on their natural capital and aspirations. Ruawaipu had opportunities for expansion of bee keeping based on the presence of large areas of Manuka trees and a high price premium for Manuka honey. Vineyards had been present in the past and expansion was occurring in the region. Dairying has also occurred in the past and all of the properties had flat areas suitable for dairying. Potential also existed for organic farming especially those farms that had not applied pesticides or fertilisers. Many of the properties had direct access to the coast line and this offered an opportunity for aquaculture. The opportunity for tourism was noted with the advantage of properties along the coast having the capacity to network with each other to provide recreational services. Waimarama identified cultural tourism, *papakaianga* (family housing), biodiversity management and olives. Aohanga were keen to explore forestry as a form of carbon farming.

The application of the WFROP model to the Aohanga property enabled the owners to evaluate land-use options that met their farm objectives including: i) maximising farm income, ii) minimising N leached, iii) minimising GHG emitted from the farm, and iv) maintaining the option to trade-in carbon in the future. This model used the base performance of the farm as generated by Farmax and Overseer along with Land-use Capability classes identified from national resource inventory maps and then used development scenarios to optimise the farm for profitability, productivity and environmental impacts. This therefore took the decision making beyond optimising the current land use to exploring alternatives to meet a wider range of functions including a future's perspective that took into account the diversity of the system. The scenario generated by the WFROP that was of most interest to the owners was forestry as it had the highest gross margins, lowest GHG emissions and lowest N leaching.

The use of an expert panel that had knowledge of local development generated a number of key success factors that would be required to enable future land use. These included capital investment, minimum size of economic unit, product quality assurance, local market, infrastructure, and people skill. Within the IDMF, these key success factors are used to test the feasibility of land-use options to deliver to the aspirations.

The Ngati Hine, Ruawaipu and Waimarama cases all introduced the concept of networking farms to realise sustainable land-use profitability. This was explored in depth with the Ngati Hine case where the key leverage points to overcoming barriers to collaboration between the owners of several land blocks were identified, by Ngati Hine, through the development of a causal loop diagram (Figure 3). Four subsystems were identified: clear direction, governance, trust and engagement. The leverage points included: strong leadership, income, building capacity and clear direction that had to be well communicated. Ecotourism was an economic activity identified by Ruawaipu participants that could be enhanced by coastal land blocks working together. Characteristics of the land that lent itself to tourism were i) all properties in close proximity to the sea, and ii) pastoral landscape vista and presence of indigenous bush. The potential to supply readily *kai*

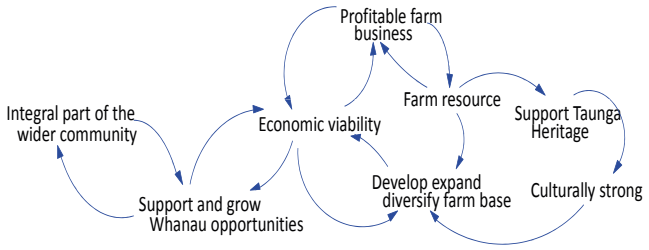


***Figure 2:*** *Fragment of a causal loop diagram developed with Waimarama landowners to illustrate the relationships between economic viability, farm business, cultural heritage and local development of the Māori case-study farms in New Zealand.*

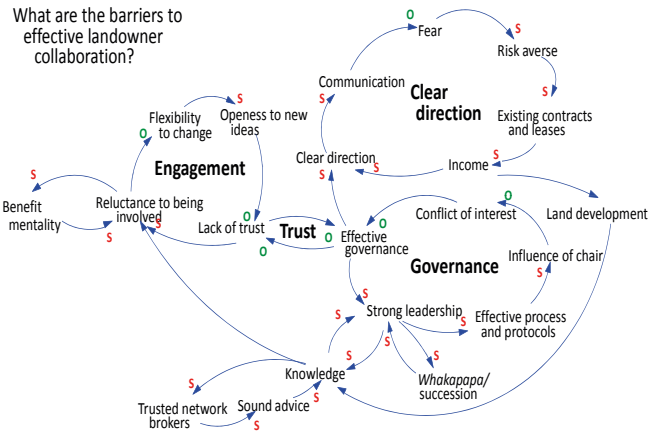


***Figure 3:*** *Causal loop diagram representing the system of barriers to collaboration by Ngati Hine networked Māori case-study farms in New Zealand. S on the arrow heads means that the factors will behave in the same direction whereas O means they will behave in opposite directions.*

*moana* (indigenous seafood), and vegetation growing on the farms, e.g. *puha* (water nasturtium) and *pikopiko* (fern shoot growing in a damp shady area of the indigenous forest), to visitors staying on farm and local markets was explored using the IDMF and these activities were identified as opportunities to market test. The products obtained from indigenous vegetation such as Manuka (oil, honey) and flax (oil, cosmetics) have found a ready market and provided local jobs.

Developing these enterprises has the potential to enhance also resource condition as the pressure may be removed from attempting to grow grass on steep hill, low-producing land and use the reverting scrub as a productive source of product while it matures into indigenous bush (forest). A visualisation agent-based model linked to GIS was applied to Waimarama to identify the potential collective outcomes delivered from Māori blocks networked across different land uses. Three scenarios based on land use identified by Waimarama owners included improved pastoral farming, biodiversity priority, and pressure from lifestyle block development. They were modelled and the output measured in relation to the aspiration themes identified through the systems workshops. An example of the results is given in Figure 4 where all values improved (i.e. economic viability) or were not affected (heritage) by the simulated scenario-improved pastoral farming.

### *Deliberating the choice of land use*

The deliberation framework was developed to organise the process of determining and making transparent the consequences of land use across the functions (goals, aspirations) articulated by the landowners and for trade-offs to be identified (Table I). The deliberations were informed to varying degrees by the outputs from the different models that were applied to the blocks. Farmax guided the land-use choice and estimated farm profitability; Overseer produced the data to parameterise the environmental functions; The WFROP model optimised land for a number of uses. Trade-offs between achieving gross margins and reducing environmental emissions were made transparent. The agent-based model linked to GIS enabled trade-offs to be identified when farms were networked. Table I gives an example of the use of the deliberation framework to identify the trade-offs between the functions identified from their aspirations and goals associated with a choice of land use. Figure 4 outlines the trade-offs identified for the farm optimisation scenario for potential networked farms at Waimarama. At all times the researchers and landowners were interacting, with the landowners posing questions and researchers undertaking analysis and reporting back for their consideration.

## ■ DISCUSSION

We organised our discussion around four themes: i) West meets South when the benefit statement is constructed by science based on using a resource sufficiency view based on the optimisation of a single function (e.g. profit maximisation); ii) South meets West when the benefit statement must align with a functional integrity view with multiple functions as dictated by Māori landowners; iii) the role of farm networking within localised communities to create new trajectories for development that builds resilience within individual farms through the use of human and ecological dimensions of livestock farming; and iv) generic applications of the IDMF.

### *West meets South*

In many instances research and other supporting industries interact with landowners at the stage when the questions asked is "what is my current performance and how can I improve it?" using the IDMF described in Figure 1. Technologies and models are all aimed at efficiency and optimisation of the current system to achieve the single objective function of farm profitability. Although interactions with Māori landowners illustrate the relationship between farm profit and other aspirations such as *whanau* (family) well-being and ability to undertake ecotourism, this information is rarely relayed to researchers. There will therefore be many instances where a particular financially optimal option will not be chosen because it involves a trade-off with another non-financial function such as risk to loss of land or not providing jobs for *whanau*. This indicates that farm performance has to be measured within a holistic context that includes environmental, cultural, economic and social indicators.

Research and supporting industries can therefore target more effectively their contribution by informing and utilising the decision-making framework in conjunction with landowners. This will offer the opportunity to explore the use of technologies and systems in achieving a balance of functions. The decision-making framework can be used to assist in targeting the questions that the landowners wish to pose and choosing the appropriate analytical tool to allow exploration of the questions. The iterative nature of the process to inform landowner choice requires that the researchers and industry actively engage with the processes embedded in the decision framework and recognise the dynamics of the situation.

### *South meets West*

A combination of *whakapapa*, land-use modelling and customary knowledge is seen as the key to improving the utilisation and sustainable development of Māori land with multiple owners. The IDMF provides a framework that will organise multiple activities and coordinate different quantitative and qualitative data sets in a visual format that allows for discussion and deliberation within a collective decision-making environment. The development and application of the IDMF across a variety of Māori land cases showed the relationship and interactions between the different functions and how not achieving one function had flow-on consequences, intended and unintended, to the other functions,

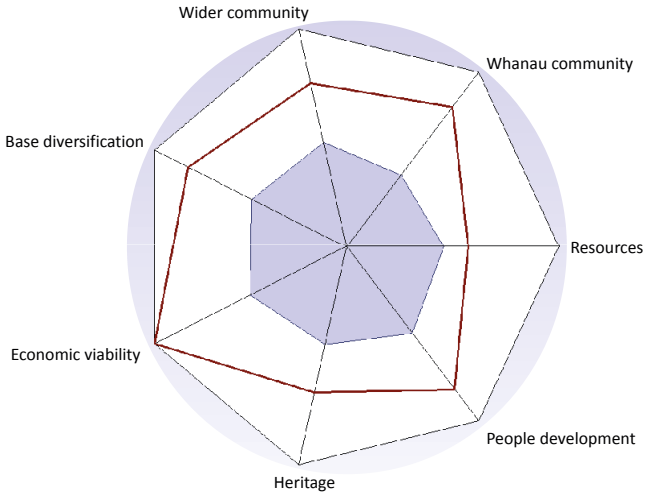


***Figure 4:*** *Trade-off analysis for networked properties at Waimarama, Māori case-study farms in New Zealand. Each point represents a collective value, the inside shape is the current status and the red line is the new measure of each value for the improved pastoral farming simulated scenario.*

e.g. at Waimarama failing to reach farm profitability impacted on their ability to create opportunities that benefited *whanau* through cultural heritage for use in diversifying economic activities. It also allowed landowners to identify the trade-offs between functions generated by a particular land-use option and to make an acceptance judgement. This understanding guides the exploration of strategies that will enable the attainment of several functions simultaneously. In this way there is a strong opportunity to use the IDMF as a means to guide the attainment of functional integrity.

## *Networking farms*

The concept of *whanau* was an integral part of the research-enabling connections to be made with people and land and gave an entry point into the community. The multiple-ownership structure is based on extended family connections and enables an individual to be connected to more than one property (Kingi, 2009a). This enables the transfer of information between farms and allows opportunity to network physically enterprises as an individual may hold a decision-making role on the governing committee of more than one farm. As shown by Waimarama's case there is a potential for land-use diversification to enable achievement of goals where strategic alliances need to be formed and institutional structures defined for viable business to occur. Amalgamations of Māori land have occurred to increase critical mass thereby enhancing profitability (Vallance, 2003). The work on barriers to collaboration undertaken by Ngati Hine indicates that leadership and effective governance are key leverage points to achieving collaboration. Research and industry support would do well to understand these barriers and design effective interventions and associated action plans in partnership with landowners.

## *Generic applicability*

The IDMF has linked indigenous knowledge with Western science and industry knowledge to form a holistic framework for framing questions, and evaluating and designing land-use options that have the potential to balance multiple outcomes and confer functional integrity. The processes and tools that populate the framework can be applied to a generic audience. A crucial point in the successful implementation of the IDMF is the partnership that is formed between research, industry and landowners particularly as the analytical tools require expert knowledge to operate and interpret. There is a large amount of baseline information required before exploration of future land-use options can take place, and in some instances this may be costly to obtain. We pose a number of research questions for consideration:

– How can the effectiveness of the IDMF as a standalone framework for use by Māori owners be tested?

– Is it possible or desirable to align the formalised decision-making process with traditional decision-making practice, e.g. how effective would this be within a strategic planning exercise?

– How can the IDMF be applied as a guide to achieve functional integrity with non-Māori landowners?

– What are the gaps in the current IDMF, e.g. inclusion of market research, and how can these gaps be filled?

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REFERENCES

Alroe H.F., Kristensen E.S., Halberg N., 1999. A systems approach to research in sustainability and organic farming. *On-Farm Participatory Res.*, **58**: 179-185 (FAO REU Technical Ser. 58, Research Methodologies in Organic Farming)

Harmsworth G.R., MacKay A., 2010. Land resource assessment and evaluation on Māori land. Whenua sustainable futures with Māori land conference, Rotorua, NZ, 21-23 July 2010

Kawharu I.H., 1977. Māori land tenure: studies of a changing institution. Oxford University Press, London, UK

King W., Lambert G., Dake C., Smeaton D., 2010. Iwi future assessment of sheep and beef farm system performance and opportunities for production increases. Whenua Sustainable Futures with Māori Land Conference, Rotorua, NZ, 21-23 July 2010

Kingi T.T., 2008. Māori landownership and management. In: Making land work, Vol. 2: Case studies on customary land and development in the Pacific. Australian Agency for International Development, Canberra, Australia, 129-151

Kingi T.T., 2009a. The future of the Māori agricultural sector. *J. N.Z. Inst. Prim. Industry Manage.*, **13** (2): 23-26

Kingi T.T., 2009b. Māori landownership and economic development. *N.Z. Law J.* (Nov.): 396-400

Kingi T.T., Wedderburn M.E., Montes de Oca O., 2010a. Balancing cultural imperatives into agricultural development and environmental management: A decision making framework for Māori landowners. Abstract for workshop. Whenua sustainable futures with Māori land conference, Rotorua, NZ, 21-23 July 2010

Marsden M., 1975. God, man and universe: A Māori view. In: *Te ao hurihuri*: The world moves on (Ed. King M.), Hicks Smith & Sons, Wellington, NZ, 191-219

Marsden M., Henare T.A., 1992. *Kaitiakitanga*: A definitive introduction to the holistic world view of the Māori. Ministry for the Environment, Wellington, NZ

Ministry for the Environment, 1997. State of New Zealand's environment. Ministry for the Environment, Wellington, NZ

Statistics New Zealand, 2005. www.stats.govt.nz/

Statistics New Zealand, 2010. www.stats.govt.nz/

Thompson P.B., 1997. The varieties of sustainability in livestock farming. In: Livestock farming systems - More than food production. In: Proc. 4th Int. Symp. Livestock farming systems (Ed. Sørensen J.T.). *EAAP Publ.* (89): 5-15

Tipene P., 2010. Ngati Hinetanga and the Land. Whenua sustainable futures with Māori land conference, Rotorua, NZ, 21-23 July 2010

Vallance R.D., 2003. Ngati Whakaue Tribal Lands - a Māori Incorporation with a large scale farming operation as its original core business. In: Proc. New Zealand Grassland Association, **65**: 49-52

Wedderburn M.E., Parminter T.G., Webby R.W., O'Connor M.B., Power I.A., 2004a. The interconnections of Māori, landscape and business. Agri-Food Research network, Landscape and Rurality, Canberra, Australia

Wedderburn M.E., Parminter T.G., Webby R.W., Pikia R., 2004b. Land stewardship and farming for economic social and cultural goals: A Māori perspective. OECD Expert meeting on farm management indicators and the environment, Palmerston North, NZ, 8-12 March 2004

## *Résumé*

**Wedderburn M.E., Kingi T.T., Paine M.S., Montes de Oca O.**
L'élevage Maori réussit-il l'intégrité fonctionnelle?

Cet article utilise une analyse historique du développement agricole pour explorer l'intégrité fonctionnelle du paysage rural de la Nouvelle-Zélande s'appuyant sur un programme national d'expansion des produits agricoles. Le concept de l'intégrité fonctionnelle est enrichi par les activités agricoles des Maoris car il introduit une nouvelle série de fonctions liées aux aspirations des exploitants des terres autochtones. Un cadre de prise de décision intégrée (CPDI) de l'utilisation des terres a été développé et appliqué à quatre cas d'étude de fermes māoris qui voulaient utiliser les performances des terres pour répondre à des objectifs ambitieux. Le CPDI a associé connaissance indigène, science occidentale et connaissances de l'industrie pour former un cadre global pour la formulation des questions, et évaluer et envisager les options d'utilisation des terres qui ont le potentiel d'équilibrer les résultats multiples et de conférer l'intégrité fonctionnelle. Le CPDI favorise l'organisation de nombreuses activités et la coordination des différents jeux de données quantitatifs et qualitatifs dans un format visuel qui permet la discussion au sein d'un environnement de prise de décision collective. Le cadre s'est révélé utile pour explorer en toute transparence les compromis entre des fonctions divergentes. Cette compréhension guide l'exploration de stratégies qui permettront de réaliser simultanément plusieurs fonctions.


***Mots-clés :*** Maori, utilisation des terres, décision, gestion foncière durable, Nouvelle-Zélande


## *Resumen*

**Wedderburn M.E., Kingi T.T., Paine M.S., Montes de Oca O.**
La ganadería Maorí logra integridad funcional?

El presente artículo utiliza un análisis histórico del desarrollo de la agricultura para explorar la integridad funcional del paisaje rural en Nueva Zelanda, surgiendo de un intento para mejorar los recursos agrícolas. El concepto de integridad funcional se extiende a la producción Maorí, ya que introduce un conjunto mayor de funciones relacionadas con las aspiraciones de los terratenientes indígenas. Se desarrolló un cuadro de toma de decisiones integrando (CTDI) del uso de la tierra y se aplicó a cuatro estudios de caso de fincas Maorí, que deseaban utilizar el rendimiento de la tierra para alcanzar sus objetivos. El CTDI relaciona el conocimiento indígena con la ciencia occidental y el conocimiento industrial, para formar un cuadro holístico para plantear preguntas y evaluar y diseñar las opciones de utilización de la tierra que tendrán el potencial de balancear múltiples resultados y conferir integridad funcional. El CTDI provee un cuadro que organizará múltiples actividades y coordinará diferentes sets de datos cualitativos y cuantitativos en un formato visual, que permitirá la discusión en un ambiente de toma de decisiones colectivo. El marco fue útil para explorar y elucidar el canje entre las diferentes funciones. Este entendimiento guía la exploración de estrategias que permitirán alcanzar varias funciones simultáneamente.


***Palabras clave:*** Maorí, uso de la tierra, toma de decisiones, ordenación de tierras sostenible, Nueva Zelanda