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International research collaboration for agricultural sustainability: opportunities for partnership with the New Zealand Sustainability Dashboard

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The New Zealand Sustainability Dashboard project Research Partners

Executive Summary

The *Agriculture Research Group on Sustainability*, and *New Zealand Sustainability Dashboard* (*NZSD*) research team in particular, could deepen and spread benefits for New Zealand and world food and fibre production by mounting strategically targeted international research collaborations. Collaboration will allow NZSD to gain international traction by introducing its methodologies and results to the international markets. Aligned research carried out concurrently overseas would hasten development of the NZSD work in New Zealand, improve its quality, and broaden the scope of the dashboard concept to deal with more than a few temperate farming systems. International research partnerships will attract more ideas, funding and people to hasten learning and refinement of an effective monitoring, benchmarking, decision-support and reporting tool for all collaborators. Co-development of the *NZSD* in very different farming systems, climates, markets and cultures could provide a more stringent test of the utility of the overarching sustainability framework and the design of sustainability metrics, how they are measured and how they are reported. Such tests are important for building trust in other countries and markets for New Zealand's produce.

Joint research must benefit overseas collaborators and assist understanding of their own agro-ecosystems, or help them develop tools for application to support their own growers and agricultural policy makers. Any specific software and decision-support tools generated by the *NZSD* can be shared directly with overseas collaborators in exchange for them sharing their components with New Zealand. Tests of their approaches in New Zealand should help their own refinements of their own sustainability dashboards.

High-level and more academic evaluations of the learning and economic, social and ecological outcomes can be replicated by separately funded international collaborations, but the bulk of each dashboard's development and application will need to be supported by separate grants from each partnering country.

Many Asian and developing economies in South America have an acute focus on building food safety and security, whereas New Zealand's focus is mainly on efficient production of commodities which are already assumed to be safe. The NZSD's drive to improve production efficiency can directly help Asian and South American nations to achieve food security. Similarly, NZSD's food safety indicators can suggest ways for their own growers and policy makers to improve local food safety records. More generally, international collaborators will find mutual benefit from co-development of key performance indicators that reflect broadly agreed dimensions of what it means to be sustainable.

A growing number of middle and high income consumers in Asia and South America are increasingly interested in the same aspects of safe and ethically produced food and fibre that many producers and consumers in New Zealand and Europe now take for granted. Therefore, although the differences in markets, producers and agro-ecosystems in many potential partner countries are large when considered as a whole, they are increasingly

similar if the needs of middle and high income consumers in overseas emerging economies are considered.

Collaborations that develop or compare applications of whole dashboard tools must be led (or co-led) by industry, business or consultancies in the host countries rather than simply by scholars from universities or government research agencies. More systems or process oriented research might well be led by researchers, but partnerships with farming networks or industry, business or consulting teams would still be essential. This reflects the fundamental Participatory Action Research and 'learning by doing' approach taken by the *NZSD* project.

The main recommendations from this review are:

- Collaboration should begin as soon as practicable with Australian and European (especially Scandinavian) teams.
- Relatively small scale collaboration with Asian and/or South American team should begin in 2015. This long lead time will allow the New Zealanders to consolidate their own team process and design their own prototype dashboards while building relationships, trust and funding streams with potential overseas collaborators.
- The priority of exploring collaborations should be Australia = Europe > China > South America (especially Uruguay) > Japan > Indonesia > India. This is a loose ranking based on a trade-off of the importance of the country for New Zealand exporting and the general barriers to successful collaboration, including the availability of funding and facilitators. However, research with any of these countries would be extremely valuable for development and testing of the *NZSD*.
- Selection of the priority projects for collaboration must primarily depend on having identified effective individuals, businesses or institutes to lead the partnership. The above ranking should only be applied if suitable partners have been identified in several countries, given that we do not have the time or resources to engage in all of them.
- Approaches for potential collaboration should begin with known contacts and build off existing relationships where ever possible. The success of any collaboration depends critically on finding known and trusted partners, meeting their needs and their ability to marshal support in their own country.
- The goals and methods of the initial collaboration, and accompanying milestones, should be only loosely defined. This is because the real value and innovation coming from international partnership may be surprising and unpredictable, and it may not be until a joint process and understanding is fully formed that the optimum research questions and methods are identified.

- At least five types of research question should be considered:

    1. High level comparisons of very different agricultural systems: In this model the overarching collaborative research questions must be set at a high level that transcends the details of local agricultural systems. For example, an international collaborating team could ask
        - Does soil testing lead to higher quality soil or more profitable production?
        - Do whole farm plans lead to improved performance?
        - Do farmers score Sustainability KPIs honestly and reliably?
        - Can qualitative and quantitative indicators be reliably combined or aggregated into simpler overarching sustainability scores?
        - Does imposition of sustainability 'metrology' lead to crucial dimensions of sustainability being side-lined?

       Asking very high level questions allows a stronger test of the overarching hypothesis because it is being tested on very divergent systems. The flexible design of the NZSD makes it ideal for this synthesis across national borders with different ecology, economic and social characteristics. Formalised comparisons of this type across divergent systems are generally absent from the international literature and could help global quests for sustainable agriculture.

    2. Structuring a medium to high level question along a policy or environmental continuum: For example, there is likely to be international interest in collaborative research of sustainability outcomes from dairy production along continua such as
        - low to high intensity (e.g. Indonesia cf. NZ)
        - fully housed herds raised on cut & carry feeding to grazing (e.g. China cf. NZ)
        - tropical to temperate agro-ecosystems (eg. Asia, Brazil cf. NZ).

       Similarly, there will be global interest in testing outcomes and learning for sustainability along a continuum from highly subsidised and regulated agriculture (Europe, Japan) to deregulated and unsubsidised farming (NZ & Australia). In such a study the big differences in farming systems becomes the focus of the research itself.

    3. Detailed comparisons of sustainability outcomes and choices for more closely matched farming systems: If the farming approaches are similar, the focus could be on quite detailed and sector specific outcomes measured in exactly the same way. For example, the pampas pastoral agriculture of South America and High Country farming in New Zealand confront similar challenges and opportunities (e.g. roles of fire or grazing management on weeds, maintaining soil quality at high altitude).

    4. Co-development of specific tools, learning modules or communication aids that are applicable in all systems: Each team of collaborators can build tools

or techniques to be shared by other countries and teams building their own dashboards. Such tools or components could be applied in any (or most) agricultural sectors and divergent social, ecological or economic contexts. This type of collaboration can be more tightly focussed and demonstrate more immediate value of collaboration than co-testing of systems level hypotheses.

5. Testing whether a multidimensional tool like a *NZSD* makes a difference: There can be a high level test of the value added by a very similar sustainability dashboard framework, indicators and tools (e.g. software) when applied to very different systems. Here the performance of the entire *NZSD* tool is being tested and replicated in quite different systems using a case study approach.

- Begin by consulting the NZSD co-funders to learn if they would value international collaboration; and if so, where they would see priority collaborations and on what topics. There are obvious opportunities to assist NZ Wine, kiwifruit growers (Zespri and pack houses) and Fonterra to build market value in China, India and parts of South America by targeting aspects of NZSD to match Asian consumer and regulators needs. Active, mutually beneficial and visible collaboration with researchers from these countries will add value to existing investments by NZSD's co-funders and could significantly reduce their financial and political risks.

- A mix of these tactical and immediately applied collaborative research (such as tool development) and bigger food systems questions should be sought.

- Budgeting and pacing of any collaboration needs to allow a long lead time and enable collaborators to spend a lot of time together. Tending a relationship comes first; followed by a small scale collaboration to test and demonstrate the mutual value of the collaboration (beginning in 2015); leading eventually to deeper and wider collaboration as understanding and trust grows (from 2017 onwards).

- Co-ordinate research planning with
    - New Zealand's Ministry of Foreign Affairs & Trade, NZAID
    - New Zealand companies and consultants that are growing their markets or farming operations in Australia, Asia and South America
    - International and overseas organisations (eg. AUSAID, FAO, Indian Council of Agricultural research, IFAOM, Asia-Pacific Association of Agricultural Research Institutions)
    - CRIs and New Zealand university researchers that are not formally part of the NZSD research team.

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Introduction: the value of increased international collaboration

The original *Agriculture Research Group On Sustainability* (ARGOS) is now transforming into a constellation of more varied research projects. New projects will mine and extend the ARGOS database and established sampling frame of around 100 farms spread between the kiwifruit, dairy, Sheep & beef, High Country and Ngāi Tahu sectors[1]. The new work also continues a search for ways to make New Zealand agriculture more sustainable and resilient by securing access to high value markets for our food and fibre. However the tight focus on outcomes from Integrated Management, Organic and Conventional agriculture[2] has been relaxed. The first two major new ARGOS research projects are:

- The *New Zealand Sustainability Dashboard* (2012-2018): this creates a customised web application for measuring trends in sustainability indicators for orchards, forests and vineyards and reporting them to individual growers, industry facilitators, regional and national government, and international food system stakeholders[3]
- *Agricultural Intensification and Climate Change* (2012-2014): this examines different trajectories of dairy and sheep & beef farming intensification and their relative success in adapting to climate change.

It is hoped that more research grants will be received in the coming years to complement these first two new ARGOS components, particularly so that the original vision of a 30-year longitudinal study of 100+ whole farms can be achieved. Maintaining monitoring on sheep & beef and dairy farm panels is the most immediate gap to be filled[4].

The *New Zealand Sustainability Dashboard* (*NZSD*) will integrate New Zealand sustainability measures with those used overseas and currently being marshalled by FAO into a globally recognised set of indicators for learning and bench marking across sectors, nations and markets[5]. Tight dovetailing of New Zealand and international

[1] Campbell et al. (2012)
[2] Much of the first six years of research tested the "ARGOS null hypothesis" that: *There are no differences between organic, IM and conventional farming in economic, environmental and social outcomes*.
[3] Manhire et al. (2012).
[4] Dairy NZ and *Beef+Lamb* have members on the *NZSD* governing body, but each sector was not in a position to launch the application within their own sector in the immediate future. It is hoped that they will eventually invite the team to develop a customised dashboard for their sectors, but this can not be guaranteed.
[5] FAO's Sustainability Assessments of Food and Agriculture (SAFA) will be launched in October 2013 (FAO, in press)

indicators is essential[6] and international research collaboration would drive that harmonisation process faster.

More generally, international collaborative research would:

- Build resilience and secure market access for New Zealand agricultural produce by learning sustainability approaches from overseas to 'import to New Zealand'. Linking research with researchers will guide us about what we need to do at home to build market penetration and security for our own products.
- Cost-effectively test whether the *NZSD* works in other countries, and whether and how we would need to modify it in significant ways (beyond just giving it an interface in their own language).
- Potentially change the emphasis on what we study and how we present KPIs to reach new target markets.
- Support the overseas researchers and marketers to meet their own goals for sustainability in their country (we hope that some of our experiences and specific research results may help them and that all of the above advantages would apply to our overseas collaborators' own communities)
- Help standardise sustainability metrics and reporting processes
- Facilitate sustainability data collection and benchmarking of relative sustainability performance of different countries.
- Help design the environmental components of free-trade agreements and the evaluation of their impacts on sustainability
- Contribute to understanding of resilience of global food systems[7]. Examples of the types of questions emerging from international collaboration include:
    - What are their perceptions of sustainability and how do they differ from ours?
    - Do different cultures and ecologies shape differences and commonalities in sustainability problems and solutions?
    - Can agro-environmental integrity[8] be benchmarked reliably between very different systems?

[6] Moller & MacLeod (2013) and MacLeod & Moller (2013) make the case for a globally relevant yet locally grounded sustainability monitoring and management.

[7] New Zealand's own agriculture's fortunes and performance are determined in part by changes in world food systems and increasingly connected markets. Therefore research of what is being learned in other countries potentially builds resilience into global food systems, as well as how to build resilience on New Zealand farms (Darnhofer *et al.* 2010).

- Are different agro-ecosystems more degraded and others less degraded than others?
- Are the same solutions going to work in other nations, or are our ecologies and socio-political constraints and opportunities too different?
- What is substitutable between each other's very different strategies to build sustainability?

- Build and diversify ARGOS's funding base, and hopefully do the same for any international collaborators. International collaborations could access international sources of funding streams that are set up to share lessons between countries, and leverage off any collaboration to secure research funding from within New Zealand.

Although the immediate need is to identify and prioritise international research collaborations to support the *NZSD* project, many of the benefits identified above will potentially apply to the *Intensification and Climate Change* project and especially to building additional subprojects to support the continuation of the ARGOS longitudinal panels.

Goals of this study and report

Here we report a preliminary scoping exercise to:

1. Evaluate the desirability or otherwise of establishing research collaboration between ARGOS and researchers of agricultural sustainability in China, India, Indonesian, Japan and some South American countries
2. Identify the most appropriate country, research institutions and teams for any such collaboration
3. Identify some potential research themes and specific topics for collaborative research
4. Suggest the first steps to establishing such collaborations.

Collaborations with Australian and European sustainability researchers are already emerging, so they have not been considered in detail in this report. Nevertheless the general principles for guiding collaboration in Asia and South America will assist further development of joint work with Australian and European researchers. Australia is New Zealand's most important market for agricultural produce[9] and is likely to stay that way[10].

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[8] Macleod & Moller (2013) define this as: "Sustaining the full potential of land and its natural capital, ecosystem processes and services to efficiently and indefinitely produce high quality food and fibre while enhancing natural heritage values and meeting global environmental change obligations. It recognises the need for an integrated management approach implemented across multiple spatial scales and governance jurisdictions to maintain livelihoods, social wellbeing and restore ecological integrity in New Zealand".

[9] www.stats.govt.nz/browse_for_stats/snapshots-of-nz/nz-in-profile-2012/exports.aspx

[10] http://www.newzealandnow.govt.nz/investing-in-nz/opportunities-outlook/economic-overview

This report is intended for internal use within the ARGOS team and international partners if we do invite collaboration. We record here potential leads for detailed investigation later when the *NZSD* team and framework is fully established and new potential research projects under the ARGOS umbrella are contemplated.

Methods

Market opportunities and changing consumer awareness in China and India are well researched in ARGOS report 11/05 *Sustainability Trends in Emerging Markets: Market Drivers for Sustainable Consumption in China and India* written by Tim Driver, Caroline Saunders and Meike Guenther from Lincoln University's AERU [11]. Leads from that report are briefly extended here with particular emphasis on relevance for the *NZSD* project. We have added more detailed scoping studies for Indonesia, Japan and a brief summation of opportunities in South America. We also briefly summarise emerging opportunities for collaboration with European research teams.

Our broad review was based on:

- A brief scoping of the relative importance of establishing collaborations with different countries during ARGOS's June 2012 progress meeting
- Internet and University of Otago library searches using key words linking agriculture, sustainability and China, India, Japan and Indonesia
- Internet searches of Trade & Enterprise's website and a Chinese government website
- Following up the references assembled by Driver *et al.* (2012)
- Posting an invitation to discuss collaboration on a Japanese agricultural and ecology research list server
- Recent experiences of Andrea Byrom (Landcare Research), Jon Manhire and Geoff Mavromatis (The Agribusiness Group) and Keith Woodford (Lincoln University) in their initiatives to build research links in Asia and South America
- Conducting a more detailed review of the published literature for Indonesia
- Searching for active researchers and consultants already working on Asian – New Zealand agricultural sustainability issues through 'LinkedIn' profiles and discussion groups, following up newspaper articles and networking amongst colleagues.

[11] Driver et al. (2012)

Opportunities for collaboration in Asia

Markets and Research themes in Asia

China and India have fast-growing economies and high rates of population growth. All have emerging affluent middle classes contributing to "vast increases in consumer spending"[12] as seen in the rise of supermarket chains in both countries. "There is also some indication that similar demands for sustainability credentials in food products may be developing amongst affluent consumers in these markets"[13] (Table 1). Indonesia also has a fast growing population, while Japan has a declining but relatively wealthy population. All four countries have rising concerns around food security (ongoing supply of food) and at least some markets share concerns around food safety (that the food is healthy). The recent market and political sharp reaction in Asia to a false alarm concerning botulism in infant milk formula[14] underscores the overriding importance of guaranteeing food safety in particular. Safe food processing and Agro-environmental integrity contribute directly to food safety concerns in particular. The overall thrust of the NZSD to promote production efficiency contributes to food security by New Zealand and therefore Asian research needs are likely to be similar in several respects, including protection of environmental and social well-being.

Organic agriculture and "Conservation Agriculture" offer significant potential benefits in Asia and could be fertile ARGOS research collaboration themes. The first nine years of ARGOS research focused on measuring the performance of organic, integrated management and conventional agriculture, and the NZSD will contribute to BioGro's sustainability monitoring in New Zealand.

There is a gradually increasing proportion of organic farming, but the overall proportion amongst 160 countries surveyed in 2010 was still only equivalent to 0.9 percent of all agricultural land (Table 2). By region, the highest shares are in Europe (2.1 percent) and Oceania (2.9 percent), but the latter average is highly skewed by Australia where 98% of the certified organic production is in low intensity pastoralism. The total organic agricultural area in Asia constitutes seven percent of the world's organic agricultural land. The leading Asian countries by area are China (1.4 million hectares) and India (0.8 million hectares). Compared with 2009, there has been a decrease of organic land, due to declines in China and India, but this has not affected trade. The Chinese domestic market is showing robust growth and India's exports of organic produce increased by 20 percent over the previous year.

The global adoption of "Conservation Agriculture" during 2011 is estimated at 116 m ha (Table 3) of which nearly half exists in South America. Conservation Agriculture is

[12] Driver *et al.* (2012).
[13] Driver *et al*. (2012).
[14] www.stuff.co.nz/business/farming/dairy/9025054/Faith-in-New-Zealand-shattered/

defined by FAO as no-till agriculture together with other associated management practices such as direct seeding into loose crop residues to provide soil cover and to conserve soil moisture, judicious choice of crop rotations and agroforestry tree species. Adoption in Asia, Europe and Africa is still very low and slow and Conservation Agriculture has much less momentum in Asia than the organics movement (Table 3 cf. Table 2).

A recent symposium[15] recommended establishment of long-term basic and strategic research platforms in different production systems and ecologies for monitoring the benefits of CA in terms of

- resource/input use efficiency
- pest dynamics
- soil health
- carbon sequestration
- greenhouse gas emissions

The symposium urged linkage of the research to participatory/adaptive research modules for out-scaling of potential technologies.

The symposium also concluded

- Analytic and communication tools need to be developed to help policy makers understand economic, social and political implications of CA based technologies vis-à-vis existing farmers'practices.
- multi-disciplinary, multi-stakeholder partnerships should be developed and strengthened for further fine tuning the CA based technologies.
- There is a need to encourage use of information communication tools (ICTs) for real time access of information on location specific technologies/inputs, services and farm advisory activities.
- The traders/dealers must receive updated information and training on calibration, operation and maintenance of CA.

A sustainability dashboard approach has enormous potential to operationalize this participatory approach for Conservation Agriculture in Asia.

[15] Jat et al. (2011).

Table 1: Opportunities and barriers for international collaboration with ARGOS and the *New Zealand Sustainability Dashboard*.

	China	Japan	India	Indonesia	UK/Europe	Canada/USA	South America	Australia
Rank importance of export market to New Zealand								
Importance now	3rd	6th	4th	7th	2nd	5th	8th	1st
Importance in 20 years	2nd equal	5th equal	4th	5th equal	2nd equal	7th	8th	1st
Barriers for New Zealand penetrating the market								
Cultural understanding	High	Moderate	High	High	Low	Low	Moderate	Low
Competition	Moderate	Low	Low	Low	:Low	Moderate	High, but variable	Moderate
Regulation themes	Moderate	High	Moderate	Moderate	High	Moderate	Variable	Low
Government policy influence	High	Moderate	Moderate	High	Moderate	Moderate	Variable	Low

Table 1 continued:

Relative importance of potential research themes								
Food security	High	Moderate	High	High	Low	Low	Moderate	Low
Food safety[‡]	High	High	High	Moderate	Low	Low	Moderate	Low
Consumer preference	High	Moderate	High	Low	Moderate	Low	Moderate	Low
Environmental degradation risks	High	Low	High	High	Moderate	Low	High	Moderate
Intensification threats & opportunities	High	Low	High	High	Moderate	Moderate	High	Moderate
Barriers to establishing potential research collaboration								
Language	High[†]	High	Low	High	Low	Low	Moderate	High
Cultural Understanding	High	High	High	High	Low	Low	Moderate	Low
Funding opportunities	Moderate	High	?Low	Low	High	Moderate	Moderate	High

[‡] Scores in this row signifies relative research priority, not the importance of the factor for consumers i.e. consumers in Europe, North America and Australia undoubtedly care about food safety but this expectation is now firmly embedded in food production and processing protocols and standard across the supply chains. Other than reminding the consumers and distributors of the safety of New Zealand produce, the relative importance of new research here is low.

[†] This is rapidly decreasing as younger professionals learn English.

Table 2: Global adoption of Organic Agriculture. Data are for 2010 and based on 160 countries. (Willer & Kilcher 2012).

Continent	Area (million ha)	% of global organic agriculture	% of agricultural land in region
Latin America	8.4	23%	1.4%
North America	2.7	7%	0.7%
Oceania	12.1	33%	2.9%
New Zealand	0.124	0.4%	1.1%
Australia	12.0	32%	2.9%
Asia	2.8	7%	0.5
China	1.4	4%	0.3%
India	0.78	2%	0.4%
Indonesia	0.71	2%	0.1%
Japan	0.009	0.02%	0.2%
Europe	10	27%	2.1%
Africa	1	3%	?
Global total	37	100%	0.9%

Table 3: Global adoption of Conservation Agriculture. (Jat et al. 2011)

Continent	Area (000 ha)	% of global total	% of arable crop land
South America	55,630	47.6	57.5
North America	39,981	34.1	15.4
Australia & New Zealand	17,162	14.7	69
Asia	26,30	2.2	0.5
Europe	1,150	1	0.4
Africa	368	0.3	0.1
Global total	1,16,921	100	8.5

This bigger picture suggests that there will be increasing scope for common research questions for New Zealand-Asia collaboration. However Asian countries are focussed on internal markets and food provision to alleviate poverty, whereas New Zealand is focussed predominantly on exporting and less on immediate poverty reduction and food security. Government involvement in various schemes in Asia have particular emphasis on the provisions of food safety and security, the development of green food production and mitigation of climate change as well as retention of foreign trade. While the appearance of new affluent middle-class consumers in Asia is anticipated to bring about a higher degree of environmental- or ethically-conscious consumption, this must be considered within a cultural context[16]. Nevertheless, New Zealand is also increasingly targeting provision of high quality niche markets for affluent consumers in Europe and Asia, so our respective researchers have broadly common interests. Meat consumption is increasing in China and dairy consumption is increasing in India.

[16] Driver *et al.* (2012).

Collaborations with Chinese researchers

Agriculture is enormously important for China and market opportunities for New Zealand producers are vast. China's labour force was 795 million in 2008, of which 36.7% were engaged in agriculture, 28.7 % in industry and 34.6% provide other services[17]. The population of China will only increase modestly from now on. The challenge for China is how to grow the grain to feed the animals that produce the meat for the Chinese people to eat. China has about 120 million ha of arable land (7% of the world's total) but has 21% of the world's population. This 120 million ha is sufficient to feed a vegetarian population (grain, vegetables, fruit) but there are real barriers to changing food preferences of its citizens. Last year China imported 57 million tonnes of soya beans and 10 million tonnes of maize. Another challenge is that approximately one third of the rice crop is grown on steeply terraced land where farming cannot be mechanised. Other challenges include the depleting North China aquifer, and degradation in both low- and high-altitude grasslands.

China is rapidly adopting green technology and has become a world leader in organic production. The China Green Food Development Centre CGFDC oversees certification of "Green Food" (an Integrated Management approach that is intermediate between chemical food and organic food). Green and Organic agriculture been taken up rapidly and some food safety scares have been taken very seriously by the Chinese government. Some researchers see China as leading the way with its adherence to Green agriculture[18].

The Chinese have also been setting aside huge areas for conservation. For example in Qinghai there is a conservation area of 350,000 sq km. This is 1.25 times the size of New Zealand. No development is allowed in this area, but without legumes and fencing, there will be ongoing degradation unless almost all animals are removed. Total removal of all livestock has already occurred in extensive areas of Inner Mongolia.

Driver *et al.* (2012) emphasised the emerging importance of food concerns like food safety, the value of food accreditation processes and a particular scrutiny of fortified foods (Table 4). They describe attitudes of Chinese [and Indian] consumers to organic and GM produce as follows:

> ***"****While both China and India are two of the largest providers of organic produce internationally, consumer demand for organic products remains low, with favour given to non-organic and genetically-modified (GM) products. Across several studies in China, consumers indicated that they would pay around 40 per cent more for GM goods over non-GM, while Indian studies indicated that 68 per cent of consumers would be in favour*

[17] CIA's *The World Fact book* cited on p 93 of the Navigating China NZTE report.

[18] Paull, J. (2008.) *The Greening of China's Food – Green Food, Organic Food, and Eco-Labelling.* Presented at the Sustainable Consumption and Alternative Agri-Food Systems Conference, Liege University, Alron, Belgium, 27-30 May 2008.

of the introduction of GM vegetables for purchase. Residue-free products, however, gain high support in India, with consumers specifying that they would be willing to pay a further 50 per cent premium on certified "residue-free" food products."

There is rapidly growing market for wine in China. If wanted by our New Zealand Wine co-funders, collaboration around co-development of their NZSD would be an obvious place to start.

Table 4: Key priorities for consumer choices in China and India.

China[†]	India[†]	Indonesia	Japan
Food Safety Assurance	Food Safety Assurance	Food Safety Assurance	Food Safety Assurance
Food Quality Assurance	Residue-Free	Food Waste	Food Waste
Low-Carbon	Animal Welfare Assurance	Nutritional Food	Food Security
Functional / Fortified Food	Functional / Fortified Food	Local Food	

[†] From Driver et al. 2011.

The ARGOS research on organics and proposed inclusion of a *BioGro* component to the *NZSD* study makes this an ideal theme for international collaboration. The contrast with attitudes to GM in Asia and New Zealand is stark, and therein lies a strong research opportunity in itself. What makes for such different outcomes?

Water use and supply is a rising concern in China, India and New Zealand. The *NZSD* is reaching out to the *Wheel of Water* research project which is developing a monitoring framework to guide reduction of impacts of agriculture on river and stream health in New Zealand. Hopefully their systems can be linked to those in the *NZSD* in some way and perhaps the combined package will have utility in Asia.

Although there is rising concerns for biodiversity impacts in China and India, there is little explicit research focus there, at least as visible in the international literature[19].

Landcare Research has been building links with Chinese researchers for some time and is already contributing to a large project in the Xinjiang region[20]. This seeks to understand and predict effects of land use change and climate change on natural and modified ecosystems. They are collaborating with Chinese researchers to compare and contrast outcomes and solutions in New Zealand and China along altitudinal gradients (80m below sea level to 5600m a.s.l.) The collaboration is leveraged from the Environment Co-operation Agreement[21] and the Free Trade Agreement[22] between New Zealand and China. New Zealand's Ministry for the Environment have also provided seed funding to develop collaboration with the Chinese Research Academy of Environmental Sciences[23]. An initial focus of the Landcare Research contribution is invasive species, but it is acknowledged that government priorities may change this in future work.

In a more recent initiative, Landcare Research staff are (at time of writing) through the concept stage of an MBIE International Relationship Fund proposal addressing the problem of rodent outbreaks and their impacts on crop yield and food security in eastern China. A requirement for success is that a suitable partner needs to have submitted the same proposal on the Chinese side. In this case the partner is China Agriculture Universtiy (Beijing). Funding for Landcare Research is modest ($100K pa for 3 years) but the aim is to build on the partnership, if successful, in order to be strategically placed for larger funding rounds in future. Over the last 10 years China has moved from 'aid' to 'collaboration' (jointly funded by our respective governments). It is still unclear whether they will eventually move to a purchaser/provider model, but there is potential for substantial collaboration with the *NZSD* in future.

Landcare Research, NIWA and Plant & Food Research have also formed a broader NZ-China Strategic Research Alliance. This research consortium approach focusses on (i) food safety and security (LCR & Plant and Food), (ii) non-communicable disease management (Health Research Council), and (iii) water quality (NIWA). The consortium is taking a whole-of-systems research approach that focusses on process-based understanding of ecosystem management. The collaboration will apply modelling for synthesis and integration to identify cost-effective management interventions. The New Zealand researchers have found that New Zealand's respectful, no-nonsense approach to business is admired China. New Zealand's small size makes its business initiatives

[19] Our Indonesia case study identifies a lack of international research publications as a perennial problem – much of the existing research in Asia is not readily visible, nor accessible to the international research fraternity.
[20] The material in this and following paragraph has been provided by Dr Andrea Byrom, a leader of the NZ-China project development team.
[21] http://www.mfe.govt.nz/laws/trade/china/index.html
[22] http://www.chinafta.govt.nz/
[23] http://www.craes.cn/cn/english/introduction.html

less of a threat to China. The researchers also found that working under China's 'top down' central government approach created certainty and local co-operation once a top-level political decision to collaborate had been made.

The *NZSD* research would appear to be nicely complementary to this more process and systems oriented research spearheaded by the New Zealand CRI consortium. As these teams have already started to form a relationship and a joint vision with their Chinese counterparts, this would seem to be an ideal starting place to see if collaboration around a dashboard-like platform could act as a delivery mechanism for applying the lessons from their collaboration.

There are good prospects for collaborative projects in a number of areas of China but they will take some work to develop. Prof. Woodford[24] and Sharon Lucock[25] are actively developing a research network in Qinghai Province, including with Qinghai University. These projects will be focusing on development of sustainable farming systems, but their detailed aims have not yet been determined. Together with Malcolm Cone, these Lincoln University researchers have good contacts with the kiwi horticultural entrepreneurs in Shaanxi, Yunnan and Guangxi, and with the Rural Development Institute within the Chinese Academy of Social Sciences. Shaanxi is a big kiwi fruit growing area and there is a natural potential synergy with the *NZSD* prototype development for Zespri and co-funding kiwifruit pack houses in New Zealand. A recent survey by Zespri[26] found that the green labels are well recognised in China and that Country of Origin was an important factor for trust. There was some distrust of Chinese certification which respondents felt could be faked and supermarkets were considered more trustworthy than street stalls in this matter. Better communication to consumers and reduce opportunity of counterfeits by packaging and application for 'Green Food' label are recommended. Obviously the *NZSD's* accent of eco-verification could add value in China.

Collaboration with Indian researchers

We judge the relative importance of India's markets for New Zealand to be ranked third and behind China (Table 1). The consumer and research issues relating to China are broadly applicable to India as well, although animal welfare concerns are immediately more visible in the published records from India (Tables 1 & 4).

The increasing market share for organic producers in India[27] suggests that a dashboard may have a valuable role in eco-verification and sustainability assessment there. Increasing the area of Conservation Agriculture in India can be accelerated by levelling

[24] Keith Woodford is Professor of Farm Management and Agribusiness at Lincoln University. He has a long history of international research facilitation for promoting sustainable agriculture.
[25] Sharon is studying for a PhD at Lincoln University under Prof. Woodford's supervision.
[26] Betts, E. Christensen, L. Klein, C. Mura, N. Sturgess, B. (2010.) *Chinese Consumer Behaviour Towards Sustainable Kiwifruit Production.* Report for Zespri International Limited.
[27] See chapter on organic farming in Asia by Ong Kung Wai on page 170 of Willer & Kilcher (2012).

of steeper ground to allow multiple cropping cycles, 3%-4% more cropped area, 20%-25% water saving and 10-15% increase in yield[28]. Managing this residue by adopting Conservation Agriculture will go a long way to improve the soil health and water resources in addition to enormous environmental benefits[29]. By adopting triple no-till system under CA, farmers can diversify the cereal-cereal cropping system by including a short duration *moong* bean in RW system and also enhance their profit margins in addition to improvement of natural resources leading to systems sustainability

Some of the potential collaborators for any dashboard development in India include:

- ICAR (Indian Council of Agricultural Research) The Indian Council of Agricultural Research (ICAR) is an autonomous organization under the Department of Agricultural Research and Education (DARE), Ministry of Agriculture, Government of India. The Council is the apex body for co-ordinating, guiding and managing research and education in agriculture including horticulture, fisheries and animal sciences in the entire country. With 99 ICAR institutes and 53 agricultural universities spread across India, this is one of the largest national agricultural systems in the world.
- Centre for Science and Environment (CSE) is a not-for-profit public interest research and advocacy organisation based in New Delhi, India. CSE advocates for sustainable environment-development in India, including issues of food safety and environmentally friendly farming[30]
- Environment Protection Training & Research Institute, a research and advocacy group that is part funded by the Indian government and the Swedish International Development Co-operation Agency (SIDA) [31]
- The Energy and Resources Institute[32], a University in New Delhi researching sustainable development within several disciplines.

Potential market accreditation pathways for a dashboard in India include:

- India's environmental friendly labelling EcoMark[33]

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[28] Dr Indu Sharma (cited in Jat et al. 2011).

[29] The other CA practices are direct seeded rice, bed planting and strip tillage system. For CA to be a reality in Indo-Gangetic plains, fine tuning of the existing CA technologies and proper residue management will be needed. They must be coupled with intensive studies to quantify the residue load and its long term effect on soil properties, standardizing fertilization practices, insect-pest and disease and weed dynamics. Dr Indu Sharma (cited in Jat et al. 2011) emphasizes that about 80 million tonnes of rice and wheat residue is being burnt at present, having a fertilizer replacement value of 0.8 million tonnes.

[30] http://cseindia.org/

[31] http://www.eptri.com/

[32] http://www.teriin.org/index.php?option=com_content&task=view&id=17

[33] www.mppcb.nic.in/ecomark.htm (Madhya Pradesh Pollution Control Board).

- India's Future Group[34]
- Bharti Walmart[35].

Collaboration with Indonesian researchers

A need for sustainability in Indonesia's agriculture

Indonesia is facing a dilemma: on the one hand, its economy has grown rapidly over the past 14 years to help feed its people; on the other hand Indonesia's rapid economic growth has come with a cost of environmental degradation and risk. Indonesia's economic growth, as measured by its Gross Domestic Production (GDP), has doubled in only 5 years (2004 – 2009) after the Asian financial crisis[36]. The Human Development Index (HDI) has also been increasing steadily since 1999 and a middle-class grew from 50 million people in 1999 to more than 130 million in 2011[37]. These improvements and growth present Indonesia with new opportunities for foreign markets and investment. Indeed, New Zealand has seen this opportunity as it prepares for a stronger bilateral relationship with Indonesia[38]. A regional trading scheme under the ASEAN-Australia-New Zealand Free Trade Area came into force on January 1st, 2010[39], and on January 10, 2012 in Indonesia[40]. In 2011, New Zealand's food and beverage exports totalled US$468.3 million, making Indonesia New Zealand's 11th largest export destination[41].

Although the percentage of population living under the poverty line decreased from 16.58% to 13.33% over the past five years[42], half of the population still hovers around the poverty line[43]. Ironically, the majority of poor people are living in rural areas where they have relatively better access to natural resources (particularly agriculture and fisheries). At the same time, environmental degradation, deforestation, and land use changes threaten to create a downward spiral of coupled economic growth and environmental impact.

A decade after the Brundtland Report in 1987, issues on sustainable development began to emerge in Indonesia and became one of the main objectives in every production and government sector in the country. After a hard socio-economic fall during

[34] http://www.futuregroup.in/sustainability/sustainability-overview.html
[35] http://www.bharti-walmart.in/DirectFarm-Overview.aspx
[36] BPS (Badan Pusant Statitik) (2012).
[37] Mellor & Adi (2012).
[38] Wilson (2012).
[39] Nuryanti (2010).
[40] DFAT (2011).
[41] www.nzte.govt.nz/explore-export-markets/market-research-by-industry/Food-and-beverage/Pages/Food-and-Beverage-Market-Profile-Indonesia.aspx
[42] BPS (2012).
[43] Handayani (2012).

the 1998 Asian financial crisis[44], Indonesia was engaged even more on sustainability issue, and the word 'sustainable' was inserted in many academic transcripts and government decrees to stress the importance of it for Indonesia's development. The Ministry of Research and Technology (MRT) of Indonesia released a White Paper to direct research in Indonesia towards sustainability objectives, particularly for the food, agriculture and energy sectors[45]. Indonesia aims to secure adequate food production for the sake of the whole population, while achieving economic growth through trade and export while maintaining ecosystem integrity and ecosystem services. For these reasons, Indonesia is now re-defining what "sustainability" means for its economic and social development, particularly within the agricultural sector. A comparison with New Zealand's agriculture and collaboration with its agricultural systems scientists would therefore be timely and welcomed by many scholars in Indonesia.

A brief overview of Indonesia's agriculture

Most agriculture and food industries in Indonesia are spread between two extremes of agrifood system models. The first type is the industrialized agricultural system orientated for export markets. These enterprises are pre-dominantly medium to large-scale, corporatized and technology-based. The majority of these farms (or estates) are located in the islands of Sumatra and Kalimantan (Borneo), where large areas with fertile soils can still be found in abundance. Examples of commodities produced at this end of the spectrum of food systems are palm oil, rubber, cacao, coffee, and spices. As export-oriented agro-industries, they are highly responsive to market and consumers' preferences, in a way that demands a more sustainable agricultural practice. This demand occurred, for instance, in the palm oil industry and led to the establishment of the Roundtable on Sustainable Palm Oil (RSPO) certification system[46]. The agricultural sustainability pathways of these industries share many similarities with those of New Zealand farmers and their sector industries.

The second type of food system is characterized by small-scale, community-based subsistent farming orientated to the domestic market. Basic commodities like rice, maize, cassava, tropical fruits, sugarcane, and chicken meat are produced at this end of the spectrum. Although this type of agricultural practice is spread locally all over the archipelago and also across the whole region of Southeast Asia[47], some regions are commonly designated as production centres for a particular commodity. This creates more region-based approaches to managing water, land, and infrastructure for sustainable and productive agriculture. For instance, rice production in Indonesia is located in regions such as the northern coast of Java (particularly west Java) and south Sulawesi, whereas sugarcane is produced mainly in the eastern part of Java. With

[44] Goldstein (1998).
[45] Menristek (2006).
[46] McCarthy & Zen (2010).
[47] Hanks (1972), Herdt & Capule (1983), Sombilla & Hardy (2005).

regard to agricultural sustainability, it seems no strong market feedbacks occur to drive sustainability and the government focuses more on quantity rather than the quality of the production with little regard to its environmental impacts. During the Green Revolution era (1970 – 1990s), heavy applications of fertilizers and pesticides have pushed the agro-ecosystem to its limits. Some farms have over-intensified to a point where any additional use of fertilizer no longer provides increased yields. Farmers are therefore searching for more cost-efficient and sustainable ways of farming. The concepts of organic agriculture, Integrated Management farming, and novel crop-livestock system have been suggested[48]. Uptake of these 'new' solutions is enhanced by the fact that most traditional/local agriculture systems in Indonesia had this pattern of production long before the introduction of intensification and industrial scale agriculture[49]. The challenge now is to re-introduce the local ecological knowledge of the subsistence farmers into the new agro-ecosystem approaches. In this end of Indonesia's continuum of farming systems it is the farmers themselves that are seeking to drive sustainability and improved efficiency by recreating a closed-loop or zero-waste farming operations. In contrast consumers and marketers drive the quest for sustainability in more industrialized agriculture models (eg. Indonesia's Palm Oil industry and in the New Zealand agriculture system as a whole). This contrast (i.e. producer cf. market-driven change) could be an internationally important and very interesting over-arching question for any New Zealand - Indonesia research collaboration.

The broad spectrum of agricultural systems practiced in Indonesia creates several opportunities for collaborative research between Indonesian researchers and the ARGOS team. Indonesia can learn many things from *NZSD*, particularly through the identification of sustainability indicators and feedback mechanisms of our industries – while ARGOS can benefit through testing the *NZSD* in very different case studies in Indonesia. Collaborative research will provide an insight on what sustainability really is and means in practice in different parts of the world and will provide a strong test of whether the *NZSD* is flexible enough to be applicable across diverse systems.

Some specific topics for New Zealand–Indonesia research collaboration

Indonesia's production of palm oil contributes increasingly to New Zealand's dairy industry, so this is an obvious example of a specific research topic for collaboration that can have mutual benefit to both counties. As the largest palm oil exporter in the world[50], Indonesia relies largely on the commodity for its economic growth. The oil palm industry was Indonesia's second most valuable agricultural production in 2010[51]. Furthermore, Indonesia also exports over 2.5 million tonnes of cake palm kernel each year, of which more than 50% are imported by New Zealand as a supplementary feed for dairy and

[48] Sombilla & Hardy (2005).
[49] Fernando (1993), Iskandar (2007), Soemarwoto (2007).
[50] FAO (2012).
[51] FAO (2012) reports that the three commodities with the highest production (by value) in Indonesia were rice (USD 17.95 billion), palm oil (USD 8.59 billion), and natural rubber (USD 2.96 billion) in 2010.

beef stock. Although oil palm plantation has been known as the main cause of deforestation and biodiversity loss in Indonesia's tropical rainforest[52], the country is now trying to embrace a more sustainable production pathway for the industry and to reduce the current rate of forest conversion through the RSPO certification scheme[53]. Clearly New Zealand has a vested interest in ensuring that palm oil production is sustainable and a d*ashboard* may be able to help guide and show progress to making it more sustainable.

Indonesia's dairy industry is strongly linked to the larger rice agriculture in Indonesia. Most of dairy farmers in Indonesia are small-scale farmers that practice traditional management system that includes both rice and dairy enterprises. At the household level, the dairy and/or other livestock rearing provide an additional source of income for the rice farmers, and also elevate social status[54]. In some cases, it is also an integral part of the rice farming system, particularly in the form of a closed-loop crop-livestock system i.e. rice straws are used to feed the livestock, while the manure is utilised as an organic fertiliser[55]. Due to its importance for many Indonesian farmers, both rice and dairy production have become the most protected and price-regulated commodities[56]. Various non-tariff and import tariff rates have been implemented to maintain the viability of Indonesia's domestic dairy and rice production. There is a quota on beef imports, but so far not on dairy products. On the other hand, the FTA pacts are pushing Indonesia to reduce, or even eventually dismiss any tariff barriers for agricultural products. So far the government has been trying to balance protection of its local dairy industry with free market access pressure and it is not yet clear how far deregulation will go[57].

In 2007, Indonesia grew 33% of its own total dairy needs. New Zealand, Australia, and the US supplied 44%, 30%, and 26% respectively of the remainder[58]. As the local manufacturers are competing with highly industrialized New Zealand dairy farmers that supply better and cheaper products, the farm gate price becomes an important issue for Indonesia's food system. Knock-on effects to Indonesia's rice food system are likely, so the dynamics in the global dairy and meat market have large and potentially disruptive effects on the dynamics of Indonesia's food system in general. The Lincoln Trade & Environment Model[59] that is frequently deployed by ARGOS therefore may be able to inform risks and strategies for Indonesia to be better prepared for turbulence in international dairy markets. Changing policies towards a more sustainable agriculture in the New Zealand dairy industry is not without implications for Indonesia's food systems

[52] Koh & Wilcove (2008).
[53] McCarthy & Zen (2010).
[54] Inounu *et al.* (2003).
[55] Sombilla & Hardy (2005).
[56] Nurudin (2009).
[57] Sucipto & Hatta (2009).
[58] Meylinah (2007), Sucipto & Hatta, (2009).
[59] Cagatay *et al*. (2003)

especially for rice, dairy, and palm oil agrifood systems. Equally, any moves towards a more/less sustainable practice in Indonesia will also be important for New Zealand.

The latest discussion[60] on building a sustainable consumption in Indonesia talks mainly about food safety (particularly with regard to carcinogenic substances) and reducing food-related waste (through packaging; plastic and domestic waste is the main issue) and to some extent local and organic food. Another discussion concerns provision of nutritional food, particularly for the low-income family[61]. However, recent work by Geoff Mavromatis on the liquid milk market in Indonesia showed little interest in details of food safety other than some consumers choosing UHT milk over fresh milk because of the lack of confidence in the milk safety from cool chain.

Building research links with Indonesia

Despite a rising focus on sustainable food production, few universities and research institutes have invested in research in systems and interdisciplinary approaches. Many researchers are still oriented towards a reductionist and production oriented approach in answering problems related to agriculture. At the university level, single-discipline research is still preferred to a more inter-disciplinary and systems-level approach, although several discussions have identified the need to shift emphasis of Indonesian research and education in universities to the latter approach[62].

The School of Life Sciences and Technology (SITH) at Bandung Institute of Technology (ITB)[63], was among the initial institutions to respond to a need for interdisciplinary research on agriculture. In 1997, the SITH established a study program that would facilitate interdisciplinary education and research that emphasized the triple bottom lines of Sustainable Development, Management of Natural Resources, and Tropical Environment. It was transformed into the 'Biomanagement Master's Program' in 2008 to accommodate a broader scope of biological resources management. The institution also opened a new study program for undergraduate degree in agriculture in 2011, with a particular emphasis on integrated and system approaches as well as interdisciplinary study. The 'Research Group on Biological Resources Management' was formed to facilitate the functioning of these study programs. This interdisciplinary research team consists mainly of ecologists, but also includes geographers, sociologists and economists. The study program and research group are distinct from other agricultural faculties in Indonesia by approaching agriculture in a holistic and comprehensive way.

SITH is a growing institution which is open to research collaboration from external parties. Collaborative research links with SITH is a practical and obvious place to start

[60] de Zoysa (2007).
[61] Dipti et al. (2012).
[62] Moeloek (2009).
[63] www.sith.itb.ac.id/en/

building wider links between ARGOS and Indonesian researchers and industry. SITH researchers have already researched some aspects of sustainability, for example:

- Management of natural reserves and protected areas[64]
- Agricultural system modelling[65]
- Land-use change[66]
- Biodiversity monitoring in the oil palm plantations[67]
- Integrated pest management in the oil palm plantation[68].

The SITH faculty already has significant experience of collaborative research with international bodies such as the World Bank, USAid, University of California at Berkeley, North Carolina State University (US), Kanazawa University (Japan), The Netherlands Royal Academics of Sciences and Arts (the Netherlands), Erasmus Mundus (European Union), etc. However, there has not yet been any research collaboration with a specific focus on agricultural sustainability.

The SITH researchers do not yet regularly publish in international journals, though they are very keen to do so. Collaboration with ARGOS researchers would be a very good way to start international publishing and is likely to be a strong motivation for establishing research partnership.

In future the collaboration could stretch to form wider networks in Indonesia. SITH's existing networks and local situation could help by:

- Building links to other faculties in ITB (School of Business and Management, School of Architecture, Planning, and Policy Development),
- Accessing potential research funding from government agencies (Ministry of Research and Technology, Ministry of Forestry, Ministry of Environment, Ministry of Agriculture, and Ministry of Marine Affairs and Fisheries, as well as regional councils),
- Inviting research collaboration with other research institutes (Indonesian Institute of Sciences, The World Agroforestry Centre, The Agency for the Assessment and Application of Technology).
- Inviting research collaboration with NGOs (Birdlife Indonesia, WWF, The Nature Conservancy, etc.)
- Promoting community outreach and research uptake
- Building links with business corporations (Astra Agro Lestari [palm oil industry], Charoen Pokphand [aquaculture and agriculture], PTPN [plantation industry], etc.), some of which may lead to commercial co-funding.

Some challenges for collaborative research with Indonesia concern

- Language barriers
- Navigating bureaucracy and different research cultures

[64] Hendiani *et al.* (2007), Bickford *et al.* (2008).
[65] Sulistyawati *et al.* (2005).
[66] Nganro (2008).
[67] Iskandar & Erdelen (2006), Irawan & Iskandar (2010).
[68] Anggriani & Permana (2010).

- Developing good communication between the research institutions
- Coping with limited overall amounts of government funding
- Difficulties in long term planning (funds are released on a yearly basis compared to the 2-6 year funding cycles brokered in the New Zealand government funding system).

New Zealand's Ministry of Foreign Affairs & Trade has recently applied wider selection criteria to scholarship applications, so there is every prospect that postgraduate students could be co-supervised and co-hosted by New Zealand and Asian Universities on topics related to the NZSD[69].

Collaboration with Japanese researchers

Prospects for sustainable agriculture in Japan

The population of Japan was 127,799 in 2011, and has been declining every year since 2006. The proportion of the people over 65 years old was 23% in 2011, and is likely to rise to over 40% by 2050. Sixty-one percent of all food from imports[70], but this is likely to increase greatly as the population ages. Approximately 77% of Japanese respondents to a survey said that they are concerned about the food security in the future[71]. Diversifying trades from different countries may provide Japan more security in case of climate-driven production reduction. For example Japan imports almost all its beef from Australia. In the case of prolonged drought, relying on just a few countries for imports could threaten Japanese food security. Therefore, as well as trying to promote more food production sufficiency within Japan, national policy is to secure safe and affordable agricultural imports from overseas and diversify its source of imports. Although Japan has a rising concern about overall food security, at the moment its population is well fed because of the countries prosperity and ability to afford imports – so this makes the situation slightly less pressing and urgent for Japan compared with China and Indonesia. We have therefore scored food security as of moderate importance for Japan in Table 1.

[69] One of the co-authors of this report, Angga Dwiartama, is currently completing a PhD at the University of Otago's Centre for Sustainability. He is comparing the resilience of Indonesia's rice agriculture and New Zealand's kiwifruit sector. He is enthusiastic about helping establish collaboration with ARGOS when he returns to Indonesia in 2014. He is confident that a productive and mutually beneficial partnership between Indonesian and New Zealand researchers can be forged. Similarly, one of Prof. Keith Woodford former graduate students, Dr Taslim Sjah, is a lecturer and researcher at the Faculty of Agriculture, University of Mataram in Lombok, Indonesia. The faculty itself has had some significant research collaboration with other institutions nationally and internationally (e.g. ACIAR-Australia and Germany). The island is known to be one of the centres for rice production, but also growing in meat production, bio-diesel and tourism (due to its proximity to Bali). Another co-author of this report, Geoff Mavromatis, is currently researching in Indonesia, Philippines and Myanmar.

[70] Ministry of Agriculture, Forestry and Fisheries (2011).

[71] The Japanese Government (2006).

Food safety rates high among the Japanese consumer's main concerns. In recent years, some vegetables imported from China contained too much agricultural chemicals and Japanese consumers who ate the product suffered food poisoning. Given these incidences, there is increasing interest among consumers on purchasing organic produce. Japan produces only 0.1% of all food from organic sources, but imports five times more from overseas. The amount of imported organic fruits increased from 4,000 tonnes in 2001 to 18,000 tonnes in 2003. Since the Fukushima's nuclear disaster, consumers are increasingly alert about food safety. Hence 'green and clean' image of New Zealand produces is hugely important in assuring Japanese consumers. New Zealand's Trade and Enterprise website[72] warns that the Japanese market is challenging with consumers having exacting standards and expectations. In order to facilitate a smooth entry into the market, comprehensive groundwork encompassing industry research, due diligence and market preparation are of critical importance.

Japan's Free Trade Agreement has negatively impacted Japanese farmers, particularly those who were engaged in growing rice. FTA has forced Japan to import rice from the U.S.A., and driven many Japanese farmers to cease rice production. Many farmers show concern towards Trans Pacific Partnership Agreement as it might put more local farmers out of business and reduce food self-sufficiency of the nation[73]. Indeed there has been severe depopulation of rural areas of Japan and increasing parcels of farm land are abandoned altogether, particularly in steeper areas[74].

In general Japan's agriculture is much more regulated and frequently subsidised, so there is a fundamental contrast with New Zealand's Neo-liberal approach. Japan has a national policy in operation to reduce its rice production in order to drive up the price and pays farmers for rotating crops on some land between rice, wheat and fallow seasons in some places. There are also the beginnings of Paid Ecosystem Services schemes being developed to grow rice in ecologically friendly ways that support fish passage and prolonged periods of wetting to promote fish breeding in paddy fields.

While rainfall has been abundant in Japan, energy is a significant limiting source for Japan. The country produced 4% of its energy needs[75]. The prices of imported forage (corn and hay) and petrol and diesel have increased in the recent years, pushing many farmers out of business. Approximately 12 million tonnes of milk is consumed per year in Japan. Of this consumption, 813 0000 tonnes are produced within Japan, but this production has been declining in recent years. Much of Japan's land is mountainous and unsuitable for agriculture, so there is growing pressure for more efficient production from the remainder.

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[72] www.nzte.govt.nz/explore-export-markets/market-research-by-industry/Food-and-beverage/Pages/Food-and-Beverage-in-Japan.aspx

[73] Hosono (2011).

[74] Japan Satoyama Satoumi Assessment (2010).

[75] Ministry of Energy Resources (2011).

In Japan, agriculture and horticulture are considered a world apart. The former refers to livestock production (cows and pigs) and the latter would be mainly vegetables and fruit orchards. The *NZSD* initially covers horticulture but hopes to extend to dairy and sheep & beef growing eventually.

A 4 minute video describing the problems Japan faces and potential solutions towards has been produced by Japan's Ministry of Agriculture, Forestry and Fisheries http://www.maff.go.jp/e/grv2422/.

This brief overview suggests that there is likely to be increasing use and support of a tool like the *NZSD* in Japan in future.

Some mutually relevant research themes for collaboration

Japanese agriculturalists refer to "conservation farming", a kind of agri-environmental scheme for farmers who are farming sustainably by adopting organic practice. Government pays them certain amount each month or year for looking after the farming environment and 216,287 farmers have signed up by March 2013[76]. Clearly a *NZSD* -like study could support such agro-environment schemes and build the support amongst consumers for their produce.

A 's*atoyama*' concept is espoused - a holistic and landscape view of production areas and the farmland[77]. Conservation agriculture in which production aids ecosystem function and provides wildlife habitats and nutrient recycling is incorporated in the satoyama. New Zealand's farmers and consumers tend to divide 'production areas' from 'natural' and 'conservation' (really 'preservation') areas. In Japan *satoyama* emphasises that ecosystem function in non-productive areas ensure production in the 'productive' areas and vice versa[78]. Just as the *NZSD* will trial organic production indicators by working with BioGro, it could trial *satoyama* processes as part of a wider continuum of 'natural farming' concepts like the organic approach. Dr Catherine Knight is an Honorary Research Associate at Massey University with a particular interest in links with Japan and the Satoyama concepts.

The more recent concept of '*Satoumi'* has applied the Satoyama general principles to integrated coastal ecosystem management. *Satoumi* could have longer term relevance to the *NZSD* project when it includes aquaculture (projected for inclusion around years 5 and 6). The joining of *satoyama* and *satoumi*, and its associated holistic principles of combining biophysical and human connections and wellbeing (including spiritual realms)

[76] Ministry of Agriculture, Forestry and Fisheries (2013).
[77] Japan Satoyama Satoumi Assessment (2010); Bélair et al. (2010); Duraiappah et al. (2012); Ichukawa (2012).
[78] For more details see Knights (2010).

is very similar to the Māori concept of "*Ki Uta, Ki Tai*"[79] and its incorporation of kaitiakitanga and human values[80].

New Zealand's dairy industry (and the government) appears to have a much better system as to ensure dairy farmers business is protected in the long term (e.g., pay out in response of drought etc.). In Japan, farmers are generally seen as hardworking but poor, while New Zealand farmers, especially dairy farmers, are perceived to be wealthy. Japan needs to learn how to ensure farming in Japan can be more profitable to encourage young generations to pursue food production as an attractive career choice.

Each year Japan throws away perfectly edible food in a quantity that is three times that of the global food aid volumes. Obviously food waste is a rising issue in the world and indicators of it in the *NZSD* would be very valuable. Collaboration with Japan to design such indicators could be of mutual interest.

Aside from collaboration on the general concepts discussed above, the following more specific considerations will guide a potentially mutually rewarding New Zealand – Japanese research coalition.

- The biggest sectors of mutual interest would be dairy, which is concentrated in Hokkaido (northern, cool climate)[81].
- Rice production is important for Japan, so if the *NZSD* team builds links with Indonesian researchers around monitoring and reporting rice production, there is a possibility for multi-national linkages that would add synergy and accelerate learning.
- There are too few vineyards in Japan to make collaboration useful.
- No lamb is produced.
- Some kiwifruit (29 900 tonnes per year) is grown[82]. As importantly, the Zespri marketing of KiwiGreen conventional and organic kiwifruit relies heavily on the Japanese market, so our *NZSD* may have a particular interest in responding to Japanese consumer perceptions of environmental credentials.
- The need for increased food security and agricultural efficiency, and to lift economic rewards from farming would all be well served by the *NZSD* or a tool like it.
- A dashboard tool could help guide re-establishment of Japanese agriculture in the recent Tsunami and Fukishima disaster area.

Building contacts with Japanese science teams and industry will be time consuming and potentially politically difficult because:

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[79] This literally translates as "from the mountains to the sea".
[80] Phipps et al. (2011).
[81] http://www.naro.affrc.go.jp/english/index.html
[82] Proceedings of a conference on kiwifruit research is published in Japanese by the Japan Fruit Growers Cooperative Association at: http://www.nichienren.or.jp/home/topic/TOP/kiwi1907.htm

- Fluency in English amongst Japanese scientists is unusual and fluency in Japanese is even less frequent amongst New Zealand researchers
- Japanese kiwifruit growers and scientists may tend to see New Zealand as competitors so further research is required before approaches are made
- Websites only contain short and incomplete translations of major points in English, and the teams do not appear to include Email addresses for direct contact

One of this report's authors, Dr Yuki Fukuda, has established a consultancy to facilitate New Zealand and Japan agricultural linkages[83] and could spearhead team building if funds can be obtained.

The Japan Society for Promoting Science (an equivalent of New Zealand's MBIE) has funding for NZ scientists to conduct research in Japan and vice versa[84].

Prof. Yosihiro Natuhara from Nagoya University[85] responded to our email sent on the Ecological Society of Japan listserver[86] about our wish to identify collaborators. ARGOS and his work share a strong linkage in developing sustainable framework and he is keen to discuss options further. Much of his work is on sustainable rice harvesting, so there may be opportunities for multinational collaborations as well as New Zealand-Japan links. Prof. Natuhara is publishing regularly in English. Other environmental scientists as well as sociologists and economists are involved so their transdisciplinary approach might align well with ARGOS and the *NZSD*.

Associate Professor Nisikawa Usio[87] approached Catriona MacLeod about potential collaboration with ARGOS. He is involved in a new research project looking at the environmental benefits of organic farming in rice paddy fields[88]. He is part of a research team of seven scientists[89] at the ecological restoration center of Nagoya University is focussing on restoration of Satoyama landscapes and developing supporting communities for ecological restoration by exploring four major themes:

- Effectiveness of environmentally-friendly rice farming on paddy field biodiversity and rice quality
- Developing economic incentives for sustainable rice agriculture

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[83] yuki_fukuda@hotmail.com

[84] http://www.jsps.go.jp/english/; http://www.royalsociety.org.nz/programmes/funds/international-relationships/nz-japan/

[85] Yosihiro NATUHARA, Graduate School of Environmental Studies, Nagoya University, Furo-cho, Chikusa ku, Nagoya 464-8601. natuhara@nagoya-u.jp

[86] jeconet@ml.affrc.go.jp

[87] from the Center for Transdisciplinary Research, Institute for Research Promotion at Nligata University.

[88] http://researchers.adm.niigata-u.ac.jp/R/staff/?userId=100000333&lang=en

[89] The team has two aquatic ecologists, a theoretical ecologist, an environmental economist, two agriculture economists and a food scientist.

- Identifying consumer behaviour, attitudes and perceptions towards agriculture products
- Linking dynamics of ecosystem and human behaviour for adaptive management of agricultural landscapes.

Their socio-ecological restoration project is based on Sado Island and is using reintroduction of crested ibis as a symbol and flagship project. The project, which is funded by donations from Sado City, started in May 2011 and is expected to last for three years. Their primary focus is restoration of rice paddies and associated regional communities and they would like to discuss the possibility of collaborating with ARGOS and the *NZSD* team. However, their team from several different universities and institutes is committed to specific research themes on Sado Island at least for another year and half. Opportunities for a *NZSD* collaboration are therefore more likely from mid-2014.

There is a National Institute for Agro-Environmental Sciences (NIAES), at Tsukuba, near Tokyo[90] . A very large research team (2000+ scientists) is working towards a five year plan with three objectives which emphasize basic studies and research meant to ensure the safety of agricultural production environments:

1) Assessing risk in agricultural environments and developing risk management technologies

2) Elucidating the structure of agricultural ecosystems in order to develop technologies to manage natural cycles

3) Basic research to help elucidate the functions of agricultural ecosystems.

There is a potentially good match for the *NZSD* collaboration here[91]. Collaboration with the Landcare Research and (NIAES) scientists may be facilitated by a MOU[92] promoting collaboration on conservation of biodiversity and ecosystems and reducing impacts of invasive species in natural and agricultural environments. The scope of activities under this agreement includes:

- exchange of scientists
- exchange of technical information
- co-operative research consistent with ongoing programmes of both parties.

Collaboration with South American researchers

Potential extension of ARGOS associated research into South America involves three factors:

[90] www.niaes.affrc.go.jp/index_e.html

[91] We have made contact with Dr.Tomoko Nishida and Dr Koji Yasuda at their institute to explore possible collaboration.

[92] Signed 17 November, 2006.

1. Similarity in agriculture sector profiles, especially in term of importance to export income and composition of greenhouse gas emissions. The New Zealand meat and dairy commodities occupy a very similar position in terms of economic importance as these do in several South American economies, especially Uruguay. The latter is also a similar sized population and geopolitical position of being overshadowed by a larger, more vibrant neighbouring economy (Brazil). In these cases, the emphasis is less on the distinctly neoliberal nature of New Zealand policy framework as most South American economies cannot afford to subsidise agriculture.

2. The similarities between the region and New Zealand have been recognised by New Zealand investors, some of whom have targeted South American countries for the extension of the New Zealand pastoral farming model (with all it implied benefits for environment and economy). The most obvious instance is that of dairy investment in Uruguay, Brazil and Chile. Another form of such investment involves efforts of New Zealand AID to enhance dairy farming in other South American countries (Colombia) to drive economic development). This raises interesting research questions about the transferability of such technologies and knowledge, as well as the unaccounted social and environmental implications[93].

3. It is apparent that several South American countries view Fonterra's presence in the international dairy market as an indication of success and are seeking to emulate New Zealand Dairy. While a nice vindication of achievements within the sector, this also entails a great social responsibility to verify the benefits and acknowledge the associated costs of New Zealand 'best practice' as it is interpreted from a distance. Full accounting of externalities, quantification of costs and impacts of environmental subsidies are just some examples of important research questions within the full gamut of social, environmental and economic impacts of New Zealand dairy farming when transplanted into South American social-ecological systems.

The potential outcomes of active collaboration with South American research groups would thus be the further interrogation of the relative advantages/disadvantages of neoliberal policy orientations for achieving agri-environmental benefit. Such an analysis should continue to involve comparison with Europe and, if possible, United States. A more specific research goal would be the affirmation or challenge of the applicability of the New Zealand pastoral model to other environments and societies. Introduction of a trial of the *NZSD* would in itself be a useful experiment to test the fit between New Zealand and South American systems. The *NZSD* will attempt to integrate knowledge, monitor impacts of agriculture and standardise reporting of sustainability outcomes, while simultaneously help 'learning by doing'. It could thereby have a powerful role in policy

[93] This latter situation is based on Geoff Mavromatis' account of his inclusion in New Zealand Aid funded projects.

and decisions about what can and cannot be successfully transferred from New Zealand to South American farming.

Land use conversion is a big issue in many countries of South America, especially the conversion of tropical or sub-tropical forest to agriculture. In the region, much of this involves efforts to modernise or develop their bio-economies and create sustainable and prosperous livelihoods. There is considerable investment in green agriculture and growing concern about environmental impacts in the region. Conservation Agriculture appears to be particularly prevalent in South America (Table 3) and organic agriculture is well established (Table 2), so these are areas of potential *NZSD* research synergy. In Latin America, more than 270,000 producers managed 8.4 million hectares of agricultural land organically in 2010[94]. This constitutes 23 percent of the world's organic land and 1.4 percent of the region's agricultural land. The leading countries are Argentina (4.2 million hectares), Brazil (1.8 million hectares), and Uruguay (0.9 million hectares).

New Zealand agricultural interests and researchers have good relations with Uruguay[95] in particular and many aspects of their agriculture and environment are similar between our countries. We therefore recommend that collaboration with Uruguay is given top priority amongst potential South American partners. The bulk of current collaborative research in Uruguay appears to be with European and North American researchers.

Collaborations with Brazil are also possible, perhaps spearheaded through The Brazilian Agricultural Research Corporation (EMBRAPA)[96]. The Nature Conservancy actively promotes research on climate change and sustainable grazing[97] in environments similar to those of New Zealand and Patagonia[98]. Many of the issues faced by High Country

[94] Willer & Kilcher (2012).

[95] Both the President and the Minister of Agriculture are extremely respectful of New Zealand's approach to farming, and there are already joint research programs on greenhouse gases in ruminants. The NZ Honorary Consul, Manuel (Mac) Herrera, is a Uruguayan and a Lincoln University graduate. The *New Zealand Farming Systems in Uruguay* company (http://www.nzfsu.co.nz/index.html) could provide a practical and appropriately scaled test bed for the *NZSD* if a private enterprise vehicle was chosen to underpin collaboration. Any government-led initiative could best be mounted by collaboration with The National Agricultural Research Institute of Uruguay (INIA; http://www.inia.org.uy/online/site/542566I2.php). Prof. Keith Woodford has active links with INIA and they have funded two of his four visits there in the last five years. Geoff Mavromatis has recent work experience with potential collaborators in Uruguay, and also Chile, Ecuador and Colombia.

[96] Dr Mariano Pereira de Aragao works for EMBRAPA and is a graduate of Lincoln University.

[97] Yager et al. (2009); Patty et al. (2010), Pérez et al. (2010); Anderson et al. (2011); Kessler et al. (2011).

[98] Prof. Stephan Halloy is seeking stronger research links with The University of Otago's Centre for Sustainability. He previously worked for AgResearch and therefore has a strong knowledge of New Zealand pastoral farming and biodiversity issues. He currently is the Science Coordinator, Southern Andes

farming in New Zealand are occurring in the southern portion of the Andes in Chile and Argentina. One of the approaches is to develop sustainable grazing standards and accreditation systems to complement more classic biodiversity protection initiatives deploying easements and protected natural areas[99]. Their overall goal is to integrate farm production and conservation.

Market opportunities in South America for New Zealand agricultural exports are generally small, and certainly of less value than the potential for exporting to Asia. Also, there is considerable potential for competition between South American and New Zealand produce in European, USA and Asian markets. These considerations could undermine collaboration with the NZSD unless strong mutual benefits can be identified from the joint research. There is some anecdotal evidence that Argentinean firms sell milk to Brazil that is reconstituted dry milk powder and that threatens the viability of domestic production in Brazil. Whether this would be also be a barrier to collaboration with New Zealand as the source of milk powder is not clear. There will be interest in kiwifruit and other horticulture as well which may be more of a competition concern for New Zealand.

Some Brazilian states (Sao Paolo, Parana, etc.) and Chile have good research funding agencies[100]. Elsewhere, the funding is more limited due to generally poorer economies, so overall prospects for funding collaborations with the NZSD are variable.

Conservation Region, for The Nature Conservancy and is also a Professor of Ecology, Universidad Nacional de Chilecito, Argentina.

[99] Fernández (2012); Borrelli (2012).

[100] Marísia da Silva, currently a PhD candidate (anticipated completion December 2013) at the National University of Sao Paolo (UNESP) in Brazil has been at the Centre for Sustainability as a visiting scholar for six months from February 2013. For her PhD, she is analysing energy use on dairy farms in the state of Sao Paolo and received funding from the state funding agency (FAPESP) to compare her research methods and findings with similar research in New Zealand. She has been impressed with existing research within the ARGOS project and sees potential for comparative analysis of dairy management systems in both countries that follows a similar transdisciplinary approach. Her advisor at the Faculty of Agriculture at UNESP, Osmar de Carvalho Bueno, shares Marísia's interest and has encouraged her to submit a research proposal to three research funding agencies in Brazil: FAPESP (Sao Paolo Research Federation), CAPES (Coordination for the Enhancement of Higher Education Personnel) and CNPq (National Council for Scientific and Technological Development). The initial submission of the proposal will be in the second semester of 2013 with funding decisions expected three months after submission. The proposed budget for the research project would fund research by Marísia in both Brazil and New Zealand, facilitating an official partnership between institutions in both countries.

Collaboration with European researchers

Discussions and reciprocal visits between ARGOS researchers and a coalition of four Norwegian research institutes have been underway over the past two years. The Norwegians wish to establish 'NORGOS, a project rather like ARGOS. They have invited ARGOS researchers to advise in its design and collaborate in the actual research once it is established. However, the most recent requests for research proposals from the Norwegian government have not suited the establishment of NORGOS and we cannot predict when it will come to fruition. The teams are in a holding pattern while they await future calls for funding. Prof. Hugh Campbell (University of Otago and *NZSD* research contributor) has been appointed as an Adjunct Professor at Bygdeforskning[101], a rural social research centre located at the Norwegian University of Science and Technology in Trondheim. He will maintain the links and search for the appropriate time and vehicle to escalate the collaboration over the coming years.

More recent discussions and reciprocal visits between ARGOS and researchers at the Department of Agroecology, Aarhus University, Denmark have also identified the value of a Danish project rather like ARGOS. Initial collaboration has been spearheaded by Henrik Moller's inclusion in the Danish '*MultiTrust*' project that applies a Multicriteria Assessment approach to defining and communicating the sustainability credentials of organic agriculture in Europe[102]. The *NZSD* team is currently co-writing a paper (with the *MultiTrust* project researchers) that combines the experience of the *NZSD* and *MultiTrust* team about incorporating farmers' and practitioners' knowledge alongside science for sustainability assessment[103]. This has led to formulation of plans to develop a dashboard like project in Denmark called *Applied Sustainability in the Organic Food Supply Chain*, for four years starting 2014. The project will focus on evaluating and communicating the sustainability of organic pork, egg, dairy and vegetable production. It involves a coalition of Danish researchers (mainly from Aarhus University) and the Danish Knowledge Centre for Agriculture[104] (this is a farmer-owned advocacy and research network), together with researchers from Nederland[105], USA[106], Sweden[107] and our *NZSD* team[108].

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[101] Norsk Senter for Bygdeforskning/Centre for Rural Research (www.bygdeforskning.no/en).

[102] Most of the team are from Denmark, but collaborators from Sweden, Norway and Austria are included. The team includes economists, ecologists, social researchers, media studies, political scientists and science philosophers.

[103] Henrik Moller and the leaders of the MultiTrust team are also co-editing a special feature issue (16 papers) in the *Ecology & Society* journal about Multi-criteria Assessment of sustainability. The special feature is in mid production phase and should be formally published late in 2013.

[104] www.vfl.dk/english/english

[105] Prof. Imke de Boer Wageningen University.

[106] Prof. Molly Jahn, Center for Sustainability and the Global Environment in Madison, USA.

[107] Ulf Sonesson at the Swedish Institute for Food and Biotechnology.

[108] Henrik Moller and Jon Manhire are the initial named researchers but we hope to spread the collaborative work to other *NZSD* members in future.

We are also building links with the Food and Agriculture Organization's (FAO) Sustainability Assessment of Food and Agricultural systems (SAFA) project[109] and Switzerland's RISE[110] research team. We propose to test the SAFA indicators on New Zealand case studies and to become active contributors to refinement of the SAFA system. If possible we would like to dovetail the *NZSD* procedures with those proposed by FAO, or even influence their design so that it serves New Zealand's agriculture to the greatest extent possible for such a broad ranging international tool. The RISE Sustainability Assessment tool and experience has already influenced the SAFA prototype, so we will try to discover whether it has direct benefits for the *NZSD* development and whether they might be subcontracted to speed our own tool development.

Pathways to establishing collaborations

The opportunities for international collaborations with Europe, Asia and South America are huge, but so too are the risks in investing in research with very different cultures and research procedures. A very useful report called *Navigating China* is available on the New Zealand Trade & Enterprise website[111]. It is likely to signal many of the issues also pertinent to working in India and Indonesia as well, though we caution about a common cross-cultural ignorance amongst Western professionals to lump all Asian cultures into the one – in fact many strongly held differences in norms and world views exist between Asia countries. Most New Zealand professionals would not assume that say Scandinavian and Italian cultural practices are the same simply because we consider them as part of Europe. Any initiatives to collaborate will have to be locally tuned and will need a local guide or champion to succeed.

The need for a cultural guide and face-to-face interactions suggests the following pathways to establishing fruitful collaborations to further test and develop the *NZSD*:

- Identify key researchers that have already established relationships or projects and ones known to be competent. For the *NZSD* collaborations these could include:
  - CRI and university teams already researching with Asian research teams
  - Asian and South American students currently training in New Zealand Universities (or recently graduated from them)
  - CSIRO partnerships
- Identify and enlist the guidance of agribusiness consultants that are operating in Asia and South America. In general transdisciplinary endeavour has failed to harness the collective knowledge and creative synergies of combining

[109] www.fao.org/fileadmin/user_upload/suistainability/SAFA/SAFA_Guidelines_draft_Jan_2012.pdf
[110] www.shl.bfh.ch
[111] www.nzfsa.govt.nz

consultants and academic researchers for sustainability in New Zealand. The same gap probably exists in Asia. Our rapid review has identified several potential consultants operating in Asia who might help spearhead international collaborations

- AbacusBio[112], especially by building on their development of the *Hoofprint* carbon footprint system promoted by the Alliance Meat Company to all its suppliers[113].
- Perrin Ag Consultants (Rotorua) have an increasing level of involvement in agricultural land development and investment in emerging market, including work in northern China assessing levels of farm nutrient footprints and then facilitating and implementing change[114].

- Associate with New Zealand agricultural businesses in the first stage of their operations overseas as bridgeheads to spreading out later. For example:
  - Fonterra has an expanding portfolio of dairy farms in China[115] and South America[116].
  - Alliance has built a partnership with *Grand Farm* in China, and is now the biggest meat importer into China[117].
  - *New Zealand Farming Systems in Uruguay* company[118]
- Build on existing general networks. Some relevant ones for *NZSD* research include:
  - SAFA trial teams
  - RISE 'regional hubs'
  - Diversitas
  - IFOAM
  - International Farm Production Network
  - Asia-Pacific Association of Agricultural Research Institutions (APAARI) would appear to be an ideal umbrella organisation to promote our collaboration throughout Asia. However New Zealand was no longer a member in late 2012, and has been approached to re-join.

It will be important to allow a lot of time for the relationships to grow and would be prudent to start small on a realisable project to prove the value of the collaboration.

A major potential barrier to establishing partnerships will be funding. The nature of the New Zealand research funding through the Ministry of Business, Innovation and Employment demands that milestones and the work programme are precisely defined in

[112] www.abacusbio.com
[113] Abacus Bio (2010); Otago Daily Times 7 August 2012.
[114] Lee Matheson, Email 18 July 2012.
[115] http://www.fonterra.com/global/en/about/our+locations/china/our+farms+in+china
[116] Lumsden (2011); http://www.btob.co.nz/article/fonterra-plans-pilot-dairy-farm-brazil
[117] http://meatexportnz.co.nz/tag/grand-farm/
[118] http://www.nzfsu.co.nz/index.html

advance and that the main benefits flow back to New Zealand. Therefore only very limited funds are available from the *NZSD*'s existing grant to mount any new international collaboration, but resources may be available to seed the partnerships by resourcing preliminary consultations. One of the salient benefits of partnering with businesses and research agencies in other countries could be the added leverage that this provides for new separate and potentially parallel funding applications in each other's country. China has several mechanisms to fund international collaborations, and limited funds are available from OECD. If the proposed research is to develop a tool very much like the *NZSD* itself, co-funding and hosting of a dashboard by business interests in the other country will be needed because the success of the learning for sustainability and industry facilitation depends on them owning and honing the tool within their own networks. If the proposed research investigates more fundamental processes in each other's agro-ecosystems, government or NGO funding may suffice. In this case the primary approach for collaboration could be to university and CRI-like research providers. However, our own experience with ARGOS and now the development of the *NZSD* is that our transdisciplinary and broad reach using whole farms as the unit of replication breaks the traditional mould of agricultural scientists[119]. We therefore expect that more traditional research providers will initially be very sceptical of the *NZSD's* learning by doing approach. The ideal would be to build a partnership with both agribusiness or consumer networks and agricultural research organisations in the other country, just as the *NZSD* is a Participatory Action Research coalition between researchers, consultants and industry bodies in New Zealand.

Discussion

Why should we collaborate?

This review has identified many opportunities for the NZSD research team to deepen and spread benefits for New Zealand and world food and fibre production by mounting strategically targeted international research collaborations. Collaboration will allow NZSD to gain international traction by introducing its methodologies and results to the international markets. Aligned research carried out concurrently overseas would hasten development of the NZSD work in New Zealand, improve its quality, and broaden the scope of the concept to deal with more than a few temperate farming systems. International research partnerships will attract more ideas, funding and people to hasten learning and refinement of an effective monitoring, benchmarking, decision-support and reporting tool for all collaborators. Co-development of dashboards in very different farming systems, climates, markets and cultures could provide a more stringent test of the utility of the overarching sustainability framework and the design of sustainability

[119] Campbell et al. (2012).

metrics, how they are measured and how they are reported. Such tests are important for building trust in other countries and markets for New Zealand's produce.

What are the best topics for research collaboration?

Any collaboration must be mutually beneficial to all partners, so some compromise and prolonged discussion is needed before the exact topics for collaboration can be identified. Nevertheless this brief review identified a huge range of potentially fruitful joint research themes. All the potential research themes identified for Asian collaborations are likely to appear in the *NZSD* framework, with the exception so far of the Asian particular concern around fortified foods. Overall there is less immediate emphasis on food safety in New Zealand research themes. The NZSD will need to codify and document the food safety procedures that are in place and often taken for granted in New Zealand. Similarly, our colleagues in Asia will undoubtedly place more emphasis on food security and alleviating hunger and poverty than is stressed by New Zealand research. Nevertheless, New Zealand agriculture has tremendous emphasis on production and efficiency, and has been powered over the past century by ever accelerating land use intensification[120]. Most of New Zealand's agricultural research is focussed on productivity and many of the indicators proposed for the *NZSD* will scale farming outputs against inputs and the amount of land used. While New Zealand farmers have intensified and sought efficiency and market growth primarily as a means for growing profit and maintaining export market access, the Asian and South American agricultural systems have explored the same trajectory (and now wish to accelerate it) to feed their people and initially provision local markets. Either way, the *NZSD* will be relevant to both communities and enthusiastic collaboration from both sides can be expected.

The first three phases of ARGOS research (2004-20012) concluded that choosing single pathways to more sustainable agriculture is unlikely to succeed. Indeed, differences in the average performance of different market accreditations like Organics or Integrated Management only capture marginal gains for sustainability. There was huge variation in performance within each ARGOS study panel, so the *NZSD* is designed to assist all farmers, whatever their formal farming system, to find more sustainable and resilient practice in many and varied ways. The main opportunity to meet the global crisis in food production is to raise the bar for agricultural best practice across the board in a variety of countries. We therefore urge that the *NZSD* is tested in a variety of contexts and not just to compare say organic or 'conservation farming' codes and other culturally embedded concepts like *Satoyama - Satoumi* in Japan. Comparisons between codified ways of farming is indeed useful and creates a framework to span a wide continuum of strategies, but we urge that it is not built in as central to the justification of testing the dashboard in other national contexts.

[120] MacLeod & Moller (2006).

Collaborative research topics will reflect a mix of the national interests of each partner, but hopefully will also assist in understanding global scale linkages that affect local agricultural outcomes[121]. The SAFA initiative is very broad and attempts to harmonise all food and fibre sustainability metrics around the world. Similarly, the socio-ecological landscape approach championed by the Satoyama framework and approach is now being applied throughout Asia[122]. The Millennium Assessment (2004) erected ecosystem services as a unifying framework to underscore the value of sustainable land use. More recently the top 100 challenges facing world food production and distribution systems were identified by Pretty *et al*. (2010). Collaborative research involving ARGOS and the *NZSD* can therefore challenge and strengthen refinement of the overall frameworks of the type promulgated by SAFA, the Millennium Assessment and Satoyama-Satoumi.

The general principles and rationales of Ecosystems Services, 100 Challenges, SAFA and Satoyama-Satoumi frameworks are potentially useful for generalized comparisons and benchmarking, but something like the *NZSD* or RISE tools are needed to focus and ground the application of their principles in very different Agro-ecosystems. There is a higher order trade-off between generalizability and specific of indicators to guide sustainable farming and incentivising change by benchmarking[123]. A natural scepticism of many potential collaborators from other countries, especially reduction-oriented scientists, is likely to emphasise the difference between the growing systems in say Asia and New Zealand, or between rice growing and pastoralism. Comparison of the efficacy, repeatability and interpretation of very precise sector-specific and country/culture-specific indicators is clearly ruled out in most of the collaborations we propose. Instead our partnerships can co-design and test higher order approaches like in steps 1 and 2 in Figure 1, and the whether the expected participation and learning by individual farming families eventuates at step 8[124]. There can also be collaboration in developing specific decision support tools at step 5, and the appropriate policy responses generated at step 6. Our focus on "metrologies" and the appropriateness or otherwise of metrics to guide sustainability can also be triangulated from studies in very different agro-ecosystems and societies/cultures.

At least five types of research question should be considered:

1. High level comparisons of very different agricultural systems

In this model the overarching collaborative research questions must be set at a high level that transcends the details of local agricultural systems. For example, an international collaborating team could ask

[121] Darnhofer *et al*. (2010).

[122] Kyrgyz Rebublic, China, Japan, Mongolia, South Korea, India, Iran, Nepal, Sri Lanka, Indonesia, Philippines, Thailand, Vietnam, Iraq, Oman, Saudi Arabia and Syria: see the case studies outlined in Bélair et al. (2010) and Ichikawa (2012).

[123] Schader et al. (2012).

[124] Or just as importantly, if they do not eventuate, why not and what can be done about it.

- Does soil testing lead to higher quality soil or more profitable production?
- Do whole farm plans lead to improved performance?
- Do farmers score Sustainability KPIs honestly and reliably?
- Can qualitative and quantitative indicators be reliably combined or aggregated into simpler overarching sustainability scores?
- Does imposition of sustainability 'metrology' lead to crucial dimensions of sustainability being side-lined?

Asking very high level questions allows a stronger test of the overarching hypothesis because it is being tested on very divergent systems. The flexible design of the NZSD makes it ideal for this synthesis across national borders with different ecology, economic and social characteristics. Formalised comparisons of this type across divergent systems are generally absent from the international literature and could help global quests for sustainable agriculture.

2. Structuring a medium to high level question along a policy or environmental continuum

There is likely to be international interest in collaborative research of sustainability outcomes from dairy production along continua such as

- low to high intensity (e.g. Indonesia cf. NZ)
- fully housed herds raised on cut & carry feeding to grazing (e.g. China cf. NZ)
- tropical to temperate agro-ecosystems (eg. Asia, Brazil cf. NZ).

Similarly, there will be global interest in testing outcomes and learning for sustainability along a continuum from highly subsidised and regulated agriculture (Europe, Japan) to deregulated and unsubsidised farming (NZ & Australia). In such a study the big differences in farming systems becomes the focus of the research itself. Some examples of the general and overarching questions that could be put to test by international research collaboration are:

- Can voluntary (market-driven) accreditation deliver effective and inexpensive environmental protection and enhancement in Europe and Asia?
- How much might market accreditation mechanisms substitute for regulation and subsidisation in Europe/Asia?
- Can voluntary (market-driven) accreditation help build a 'land ethic' in Europe/Asia?
- Can regulation and subsidisation build a 'land ethic' in New Zealand, Europe/Asia?
- Will a mix of models work in each of our countries, and what is critical to not change, or to change to incentivise environmental care?

3. Detailed comparisons of sustainability outcomes and choices for more closely matched farming systems

If the farming approaches are similar, the focus could be on quite detailed and sector specific outcomes measured in exactly the same way. For example, the pampas pastoral agriculture of South America and High Country farming in New Zealand

confront similar challenges and opportunities (e.g. roles of fire or grazing management on weeds, maintaining soil quality at high altitude). In such collaboration, co-development of indicators and tools or tests of best practice farming can be framed at much more detailed levels.

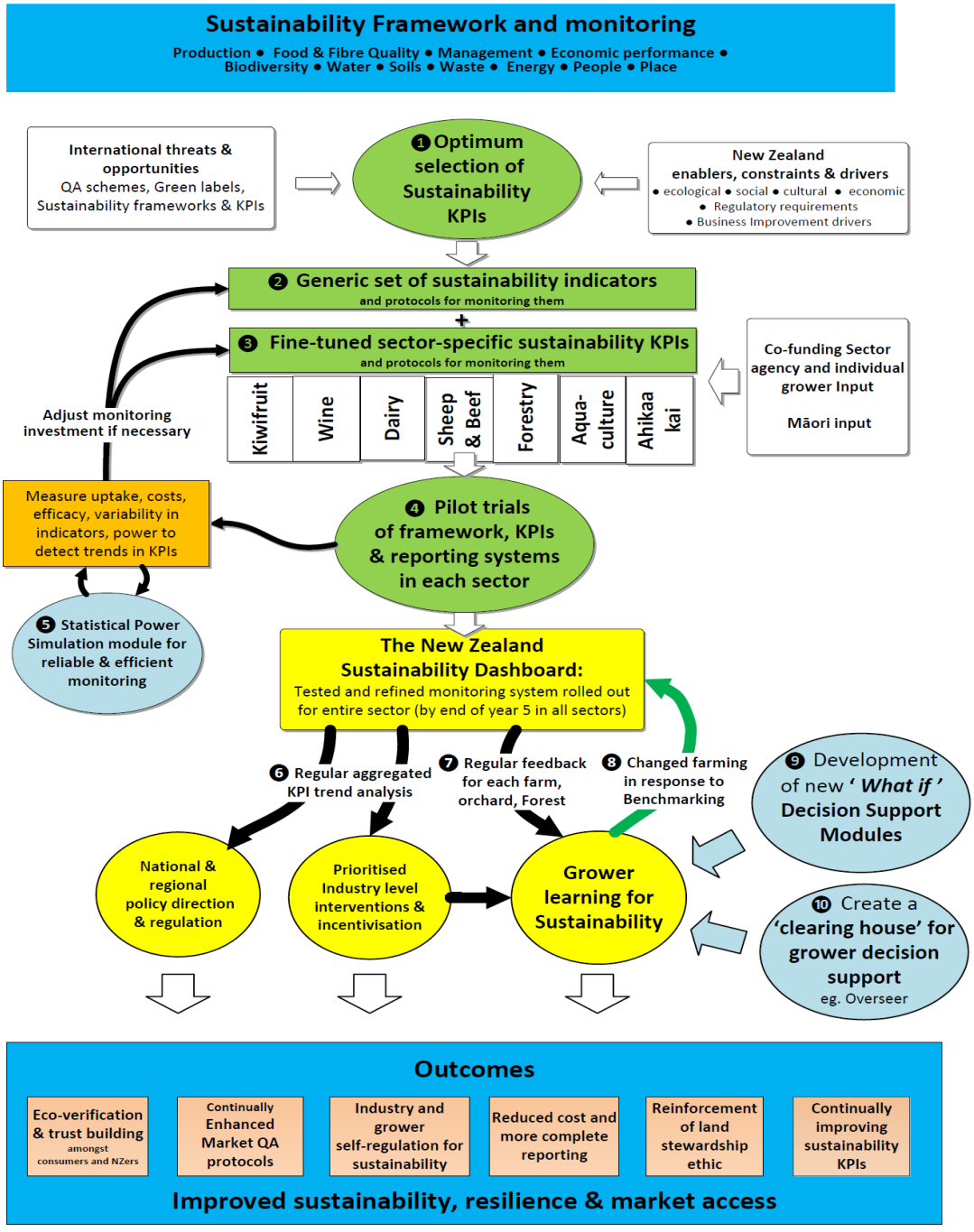

Figure 1: The New Sustainability Project Plan.

See Manhire et al. (2012) for a fuller explanation of the research's design and rationale.

4. Co-development of specific tools, learning modules or communication aids that are applicable in all systems

Each team of collaborators can build tools or techniques to be shared by other countries and teams building their own dashboards. Such tools or components could be applied in any (or most) agricultural sectors and divergent social, ecological or economic contexts. This type of collaboration can be more tightly focussed and demonstrate more immediate value of collaboration than co-testing of systems level hypotheses.

5. Testing whether a multidimensional tool like NZSD and SAFA make a difference

There can be a high level test of the value added by a very similar dashboard frameworks, indicators and tools (e.g. software) when applied to very different systems. Here the performance of the entire dashboard tool (or the SAFA framework within which it sits) is being tested and replicated in quite different systems using a case study approach.

The research collaborative process will be more culturally safe and in the end more rewarding if all participants pay attention to the process of relationship building rather than firm and prior stipulation for where the research collaboration will head or achieve. Start-up and entry processes and a primary focus on relationship building are crucial to identify mutual benefits and to cement reciprocal respect and equitable opportunity sharing as the guiding principle of exciting new partnerships. The ethics and protocols for establishing research collaborations described for China by a New Zealand Foreign Affairs and Trade booklet are very similar to those operating to guide partnerships between Māori and science research organisations[125]. A mixture of humility and confidence is needed, and nothing will collapse a partnership quicker than arrogance of an outsider 'expert' that does not listen and learn before sharing their own understanding.

Once target collaborations are more closely identified, an international contribution linking to these global research frameworks should be highlighted. However we caution about rigid planning and close contracting of expected outcomes from partnerships at the outset. This caution is needed partly because the diversity of approaches and knowledge being brought together for international collaboration is likely to bring surprise and new research priorities as the relationship and understanding between the collaborators deepens. It is also expected that overcoming language barriers and building trust for cross-cultural research will take a lot longer than might at first be hoped.

[125] See Smith (1999) and Moller et al. 2009 for detailed descriptions of the Kaupapa Māori and Participatory Action Research partnership guidelines.

Who should we collaborate with?

From a New Zealand national self-interest point of view, the current and future importance of the agricultural markets suggests that *NZSD* collaborations will be most relevant if established with Chinese, Australian and European researchers (Table 1). India comes a close fourth in terms of value of future markets. There are obviously rising opportunities and importance reasons for developing collaborations with Japanese and Indonesian teams. However the benefits of collaboration are likely to be surprising and we expect them to be two-way, so targeting overseas countries purely on the basis of the importance of markets for New Zealand food and fibre would be unwise, not to say mean spirited.

Situating collaborative research in sectors that are not competing with New Zealand produce may lessen defensiveness and fear of competition. The prospect of competition is perhaps greatest with South American colleagues.

Consolidating relationships with Australian and European collaborators is potentially much simpler and also will be extremely useful for further development of ARGOS and the *NZSD* in particular. The next stages of collaboration with Scandinavia teams are already planned for 2013 and if initial collaboration is effective, should then be deepened and scaled up from the beginning of 2014. Joint research with CSIRO and NZSD researchers to develop biodiversity indicators for production landscapes is already under discussion and part of a current CRC bid being considered for funding[126].

Collaborations with Asian researchers should also be invited and explored immediately, but then matured slowly – the complexities involved make it obvious that these will take a long time and that we should start small. There is an enormous amount of work to be done in New Zealand to get the first prototypes of the *NZSD* going with the wine and kiwifruit industries, so we should aim to have any collaborative work starting with Asian researchers scoped and funded by late 2014, for building momentum in 2015 (year three of the *NZSD* programme).

It is important to realise that this scoping document is extremely preliminary. We focussed mainly on opportunities and barriers for collaborations with Chinese, Japanese, Indonesian and Indian researchers. We have given scant regard to joint work in South America and especially in Scandinavia and Australia. There are fascinating potential projects in other parts of Asia such as Vietnam and Cambodia[127] where we could find the

[126] This potential collaboration is being led by Dr Daniel Tompkins from Landcare Research.

[127] Around 82% of Cambodians live in rural areas, with the majority dependent on agriculture to support their livelihoods. However, the agricultural sector in Cambodia remains relatively undeveloped and represents less than one-third of total Gross Domestic Product (GDP). The NZ Trade & Enterprise website notes that there is great potential to develop agriculture in Cambodia. The Government of Cambodia has recognised this and has placed extra emphasis on making agriculture a key priority, with an aim to

partners, but the challenge is to find the funds. The Australian Centre for International Agricultural Research is one potential funding source – it actively promotes research in Asia as part of the Australian Aid programme (http://aciar.gov.au/aboutus). Other potential collaborations with biodiversity researchers in the United Kingdom[128] have been discussed but are too preliminary to be included in this report.

Multinational linkages may be more efficient and lead to more rapid learning. There is no reason why collaborations need to be bilateral rather than multi-lateral, especially when networks and mutual interests between rice growers throughout Asia should be relatively easy to establish. For example, rice is a key commodity throughout Asia and our brief review has already identified support of sustainable and efficient rice production by a dashboard could gather lessons and share indicators in China, India, Indonesia, Cambodia and Japan and tie in with current research and aid programmes from Australia.

In what ways can we collaborate?

Most of the benefits of collaboration will result from sharing the task of answering common higher order questions, developing tools that the other can add to their own dashboard or testing our tool in the others agro-ecosystem. However the benefits for participating partners may often be more personal and related to shared processes for learning from each other. These could include:

- Reciprocal visits of scholars, facilitators and growers to each other's country
- Shared supervision of students
- Students doing part of their thesis work in both places
- Joint workshops in each other's country, or organisation of a symposium held within a broader international conference
- Joint publication of results in international journals (English) or in local journals (and local languages)
- Joint grant writing. We expect that two separate primary research funding grants must underpin sustainability research within each host country and research institution[129]. A third and much smaller grant focused on the overarching meta-analysis could be funded separately from the primary two grants.

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improve the population's living conditions, agriculture's contribution to GDP and to grow Cambodia's export base. Future links with Cambodia may develop led by Sophal Chhun, an economist that is currently pursuing a PhD at the University of Otago's Centre for Sustainability.

[128] This is likely to be with Prof. David Raffaelli, University of York, but could also include links to Scottish agricultural research teams. Henrik Moller and Catriona Macleod have been actively pursuing options but plans are still very preliminary.

[129] MBIE's *NZSD* grant in New Zealand and an equivalent grant from within the partner's country.

Recommendations

1. The *NZSD* research team should consolidate collaboration with Scandinavian and European colleagues in the first instance.

2. Discussions with potential partners in Asia and South America should start immediately, but the accent in the first two years should be on relationship building and identifying a small scale research project to test the collaboration. Funding and generally framed research goals should be in place by late 2014 for building joint research momentum in 2015.

3. The priority of exploring collaborations should be Australia+ Europe > China > South America (especially Uruguay) > Japan > Indonesia > India. This is a loose ranking based on a trade-off of the importance of the country for New Zealand exporting and the general barriers to successful collaboration, including the availability of funding and facilitators. However, research with any of these countries would be extremely valuable for development and testing of the *NZSD*. Also, the success of any collaboration depends critically on finding known and trusted partners, meeting their needs and their ability to marshal support in their own country. Therefore selection of the priority countries for collaboration should depend on having identified effective individuals or institutes to lead the partnership from the other side. The above ranking should only be applied if we suitable partners have been identified in several countries and we do not have the time or resources to engage in all of them.

4. Approaches for potential collaboration should begin with known contacts and build off existing relationships where ever possible.

5. All collaborations should be rooted in existing research programmes and guided by known contacts in the other country. The collaboration is most likely to succeed if it adds value to and therefore leverages off locally grounded existing research programmes.

6. If a whole sustainability dashboard tool is to be created and tested in another country, the primary local partners should include industry, business or consulting partners and a farming network. Their involvement is critical for the hosting operationalising of a dashboard and the Participatory Action Research way of learning for sustainability that it depends on. It would be best of such and industry or consulting group became the leading agency in the other country and co-opted local scholars from research institutes when and where needed.

7. Research agencies should be lead collaborators if the main subject of the joint research is more systems-oriented work to understand overarching or high level hypotheses and models concerning sustainability transitions.

8. If development of a complex Decision Support Module becomes the first focus of the collaboration, either a research institute and their scholars or an industry/consultancy group might lead or co-lead the collaboration.

9. The goals of the initial collaboration should be modest and the timetable slower than normal. It will take considerable time to build the understanding and shared knowledge from very different countries, cultures and agro-ecosystems.

10. Multinational rather than just bilateral coalitions (eg. around rice production) may emerge but should only be attempted if simpler two-way partnerships are first shown to be working well and efficiently.

11. The goals and methods of the initial collaboration, and accompanying milestones, should be only loosely defined. This is because the real value and innovation coming from international partnership may be surprising and unpredictable, and it may not be till a joint process and understanding is fully formed that the optimum research questions and methods are identified.

12. At least five types of research question should be considered:

    a. High level comparisons of very different agricultural systems
    b. Structuring a medium to high level question along a policy or environmental continuum
    c. Detailed comparisons of sustainability outcomes and choices for more closely matched farming systems
    d. Co-development of specific tools, learning modules or communication aids that are applicable in all systems
    e. Testing whether a multidimensional tool like a dashboard makes a difference.

13. Begin by consulting the NZSD co-funders to learn if they would value international collaboration; and if so, where they would see priority collaborations and on what topics. There are obvious opportunities to assist NZ Wine, kiwifruit growers (Zespri and pack houses) and Fonterra to build market value in China, India and parts of South America by targeting aspects of NZSDs to match Asian consumer and regulators needs. Active, mutually beneficial and visible collaboration with researchers from these countries will add value to existing investments by NZSD's co-funders and could significantly reduce their financial and political risks.

14. A mix of these tactical and immediately applied collaborative research (such as tool development) and bigger food systems questions should be sought.

15. Budgeting and pacing of any collaboration needs to allow a long lead time and enable collaborators to spend a lot of time together. Tending a relationship comes first; followed by a small scale collaboration to test and demonstrate the mutual value of the collaboration (beginning in 2015); leading eventually to

deeper and wider collaboration as understanding and trust grows (from 2017 onwards).

16. Co-ordinate research planning with
    a. New Zealand's Ministry of Foreign Affairs & Trade
    b. New Zealand companies and consultants that are growing their markets or farming operations in Australia, Asia and South America.
    c. International and overseas organisations e.g. AUSAID, The Australian Centre for International Agricultural Research, FAO, Indian Council of Agricultural research, IFAOM, Asia-Pacific Association of Agricultural Research Institutions.
    d. CRIs and New Zealand university researchers that are not formally part of the NZSD research team.

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