Food Landscapes: A landscape model for intensive farming

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Abstract

With rising chicken meat consumption worldwide, particularly in developing countries, there is a need to explore new approaches in designing these types of farms to assist with affordable meat production within a framework of improved environmental and economic sustainability.

This paper presents a research project that has used landscape design methodology to analyse and quantify existing intensive farming models for chicken meat production (broiler shed farms) and explores potential design interventions that can contribute to improved quadruple bottom line outcomes in intensive farming practice in NZ. It produced a design model that utilised system approaches such as industrial ecology, cradle to cradle, permaculture and zero energy buildings to reduce the intensive farming footprint while improving the interconnections between the multiple inputs and outputs required for such farming practices, within the site and broader environment.

Comparison of quantitative data on aspects such as water, energy, biodiversity and waste between the existing intensive farm model and the proposed sustainable design proved that the inclusion of landscape architectural design methodology informing intensive farm development can improve the sustainability of intensive farming in an economically viable way and contribute to a more appropriate approach to food production and land use.

Introduction

Intensive farming is a controversial topic worldwide. These farming types continue to expand throughout the world and in New Zealand (NZ) as the demand for affordable meat continues to grow. The expansion of this farming method is due to its effectiveness in producing affordable meat. Affordability being a key driver for providing protein through meat to members of society (particularly those less affluent).

NZ has a strong dependency on the agriculture sector economically, and our presence within the world of intensive farming is also prominent. In 2011 the poultry industry in NZ produced 90 million chickens (Statistics NZ, 2010) and in 2007 we produced 760,000

pigs (Statistics NZ, 2010), this intensity of production highlights the need for such systems to achieve a more sustainable approach in order to facilitate continued supply of food within a more environmentally responsible landuse framework. This paper illustrates how the NZ poultry industry could lead the way for sustainable development of intensive farming.

There are currently a number of disadvantages associated with intensive farming but their one very strong positive contribution is their confined use of land area - unlike traditional sheep and cattle farming throughout NZ that requires large land footprints. However the author believes that the full potential of intensive farms has not been realised. This paper illustrates that by utilising ecological services (eco- services) the negative impacts of intensive farms can be eliminated and/or reduced and that they can contribute to the development of more positive perceptions and outcomes for this farming methodology.

Throughout this research animal welfare had a strong influence. Landscape design methodology (in particular eco-services) and systems approaches have the ability to improve the environment not only outside the sheds but also within the sheds, thereby improving animal conditions within the buildings. Potential to improve efficiency of the farms themselves through design interventions that assist in reducing energy costs was also explored. With the incorporation of eco-services within this project, multiple benefits for farmers/owners, animals, end purchasers of the product and the environment were achieved. Food supply, animal welfare, environment and human health are intricately inter-linked through intensive farming and the outcomes of this research shows how landscape architects can contribute to addressing the current concerns linked to the poultry industry.

This research was driven by the question:
How can landscape design improve the overall sustainability of intensive farming in New Zealand, highlighting the contribution landscape architecture can make to agro-economics?

Design Model (Methodology)
The aim for this research project was to develop a design model that improves the overall sustainability of broiler shed farms throughout New Zealand using existing broiler shed

sites. This model aimed to decrease the demands intensive farming has on nonrenewable resources and resulted in farms that produced very little waste. The model facilitates the continuation of affordable meat production, improved profitably for the farmers, and amelioration of the environmental conditions in and surrounding the farms while positively affecting the health of animals within the broiler sheds.

The first site was located in Canterbury and as seen in fig.1. The main issue existing broiler shed farm design is the disorganized and sporadic layout. The sheds are highly visible within the environment and they consume a majority of the site, making them the dominant feature.

Other influences in the design model included the catchment of natural energies like sunlight and warm winds to heat buildings in winter and deflection of hot summer sun and winds. Site analysis was carried out to determine the location of the sheds to maximize natural energy catchment whilst allowing the continued use of the site as a lifestyle block.

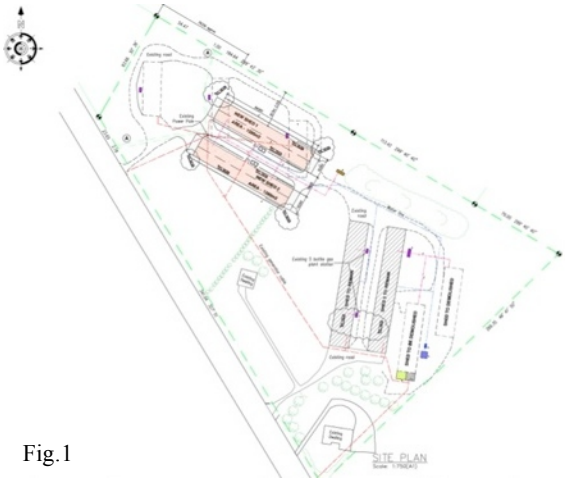

Fig.1

GIS (Geographic Information System) analysis of the site and surrounding areas was also carried out and highlighted the current conditions. There was a lack of vegetation, vast areas of agricultural farmland and the site contained friable soil conditions. GIS mapping highlighted the ecological context surrounding the site and confirmed the design model could and should contribute to ecological connections to the region.

Fig. 2 illustrates the completed design model that:

- Applies landscape-based infrastructure to provide a cleaner and healthier working environment for employees and chickens that knit the buildings and site together in a tightly woven fabric.
- Utilises living roofs as they have the potential to save substantial amounts of money by purifying water on site, utilising vegetation to cool buildings in summer by absorbing the solar energy (via photosynthesis) and insulating them in winter. They also absorb

Fig.2

airborne toxins around the site, preventing unwanted smells commonly related with broiler farms and have the potential to last twice as long as the conventional steel industrial roof.

- It also augments living roofs with other landscape design methodologies like rain gardens between the sheds, porous paving and hedgerows to attenuate, cleanse, and convey storm water across the site, utilising phytoremediation to cleanse polluted soils (especially from wash out). And combines the living roofs with solar panels to maximize catchment of the sun's energy for power. The solar power system will be connected to the grid so the farm can export excess electricity to the national grid and be credited for the same rate they pay for power. Through calculations it was determined this farm would require 110 solar panels in order to create a zero energy farm.
- Combines the restoration of wildlife structures with sustainable agriculture, livestock, ethics and the pleasures of aesthetics (Meyer, 2010).
- Produced a complex mosaic of natural forest, orchards, pastures, productive fields and wildlife corridors creating a heterogenic landscape providing an array of habitats.
- Utilises skylights within living roofs to provide natural lighting for the chickens.
- Employs deciduous planting to protect the broiler sheds from the hot summer sun and winds whilst letting the warm winds and sun through in winter.

- Provides easy access for larger vehicles throughout the site and an alternative entrance for the trucks to reduce interruptions for the residents.
- Removes nonrenewable LPG heating for renewable biomass heating facilities. It was essential to change the current heating systems to biomass heating as it utilises woodchips, a renewable organic matter that also doubles as waste from another industry (timber).
- Vegetation increases the amenity value of the site whilst improving the biodiversity within the site and region.
- Utilises white walls, as they are the most cost effective way of reducing global warming by mimicking the polar icecaps and the way they reflect sunlight back into space to cool the planet. White walls also effectively reduce the temperature within the buildings. (Montanjees, 2012)

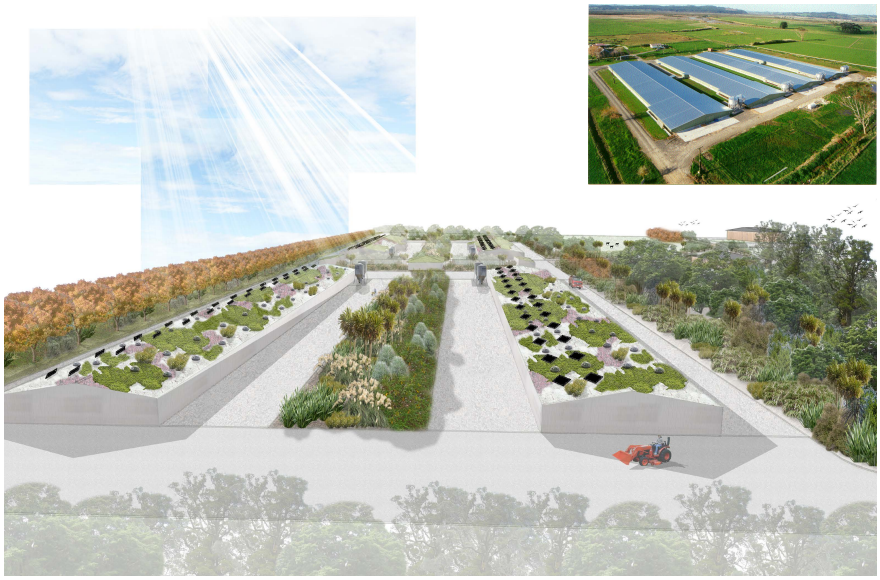

Fig.3

This visualization (fig.3) illustrates the improved aesthetics possible this model can provide for intensive farms.

Shade analysis was also undertaken to determine the height of the deciduous trees in order to protect the sheds on the northern boundary. This height was calculated at a maximum of 10m. The trees need to maintain this height, if they exceed this they will impact on the catchment of solar energy from solar panels. As New Zealand's native deciduous trees don't suit these requirements and the site conditions, exotic deciduous species were selected based on the following guidelines.

- Prevent monocultural farm landscapes by selecting deciduous plant species that are not commonly used in the Canterbury Plains farming regions.

- If other intensive farms in this region were to utilise this same model, it is important that plant species are not repeated on mass, as the aim of this design is to create heterogeneous landscapes that increase biodiversity.

The objective of this design model was to improve ecological connections and biodiversity throughout farming regions. Because of this the following criteria was created to select plant species for the remainder of the site:

- Toleration of site conditions (including rain gardens, swales, living roofs and wetlands).
- Introduce invertebrates and insects onto the site.
- Select plants from the ecological district of the site to improve landscape ecology.
- Provide habitats.
- Enhance aesthetics and amenity.

By following these criteria the design model contributed almost half of the site (3 hectares) in native vegetation to the region. If this design model were to be applied to other intensive farms throughout the area surrounding the site it would contribute 31 hectares of native vegetation to a region that is currently predominantly un-vegetated farmland and considered depauperate in terms of native biodiversity. This exposed one of the potentials of intensive farms. It condenses land area use allowing more land to be returned to nature, thus contributing to biodiversity improvements.

Running cost information was supplied from a current broiler shed farm in Christchurch. Currently on average throughout NZ it takes 22.23kwh or \$6.57 per m^2 per year to power; and 63.83kwh or \$11.97 per m^2 per year to heat using LPG. Figure 4 revealed the design

Total site area: 6.2170ha

Total shed area: 0.6ha

	Exisiting	Proposed	Reduction factor	System improvements	Savings	Total $ savings	Energy and $ savings per m^2
Vegetation	0.500ha	3.073.4ha		Living roofs, Native planting, Deciduous planting, Rain gardens, Orchards, Intensive horticulture zones	17-57% on heating and cooling consumption and costs within sheds		
Power consumption	131,612.85kwh	56,593.53 - 109,238.67kwh	Vegetation, skylights		22,374.18 - 75,019.32kwh		3.73 - 12.50kwh
Power costs	$39,427.20	$0.00	Power consumption, Solar panels		$39,427.20	$39,427.20	$6.57
Heating kwh	378,052kwh	162,562 - 313,786kwh	Vegetation, skylights		64,268 - 215,490		10.71 - 35.92kwh
Heating costs (LPG to Biomass)	$71,829.93	$9,753.75 - $22,683.14	Biomass more cost effective, vegetation		$49,146.79 - $62,076.18	$49,146.79 - $62,076.18	$8.19 - $10.35
Water collection	None	37,000l		Collection off Living roofs			

Total $ saving per m^2: \$14.76 - \$16.92

Total $ savings for farm: \$88,560.00 - \$101,520.00 per year

Fig.4

model has the potential to save this farm considerable costs and improve the property value through aesthetics.

The design model established a set of guiding principles, which were then developed for intensive broiler, shed farms.

- Change existing district plans and RMA objectives for farming by creating practical and achievable guidelines for the improvement of intensive farms (which is currently being completed).
- Minimize the impact of existing intensive farming.
- In-depth site analysis to capture natural energies.
- Improve shed environment for the chickens by optimizing and improving the environment outside the sheds.
- Increasing vegetation on these small footprint farms to improve ecological connections.
- Decrease the demands intensive farming has on power and nonrenewable resources by utilizing eco-services and renewable energies.
- Improve site interconnections and shift to maximize on site systems.
- A design model that can be implemented within a realistic budget that continues to yield profits for property owners.
- Maintain and enhance the typical land use of properties, a lifestyle block or smallholding.
- Provide a rich soft-engineered landscape that is attractive to the public and local community whilst increasing land value for the property owners.
- Achievable design interventions using current best practice and accessible technology.
- Continue the supply of affordable meat to the world by minimizing the costs of running intensive farms through use of renewable resources and eco-services.

To test the applicability of these principles the design of another site in South Head, Auckland was undertaken with significantly different environmental influences and site conditions.

GIS mapping proved it was better ecologically connected, hydrology was dominant feature with a femoral stream and swampland surrounding the northern end of the site boundary, and the soils are less permeable than Canterbury. The same design

interventions were then applied to this broiler shed farm, however there were other landscape characteristics that needed to be addressed like topography and water.

Analysis of this site defined the northern end of the site as being suitable for the location of the sheds as the gradient was less and the catchment of natural energies was higher.

Fig.5

As seen in fig 5 the design on the South Head broiler site achieves the same outcomes as the Canterbury site with a few differences because of the site conditions. They included utilisation of lower regions for wetlands and three collection ponds to cleanse water before entering the femoral stream and swampland; retiring steep slopes into native vegetation; livestock areas located in the remaining leveled areas of the site; limiting the access to one route because of site constraints; changing existing contours to maximize catchment or renewable energies; selections of deciduous plants on the north and northwest boundaries that tolerate wet feet.

The same calculations were applied to this site and determined that if this design model was applied to this site it could potentially save the owners $127,238.40 per year. Although the site constraints of this region were very different to the site in Canterbury, it was discovered that the design model could be implemented within other locations in NZ. Each design model needs to be retrofitted to the region in which the site is located. Irrespective of location, the principles and their implementation still have the potential to improve the quadruple bottom line issues associated with intensive broiler shed farming.

Detailed Design Responses and Results

Investigation into the background of farming in NZ and animal welfare identified four intricately linked aspects for improvement; the environment, economics, social and animal welfare (the Quadruple Bottom Line issues). Case studies including: the Ford Factory, Dearborne, Michigan, USA; Nick's Head Station, Poverty Bay, New Zealand; Zero Energy House, Pt Chev, Auckland, New Zealand; Kulundborg, Copenhagen, Denmark; Greening Waipara, Canterbury, New Zealand; Pig City, Netherlands and Ashof Hen Unit, Rothenfluf, Switzerland identified:

- How eco-services can improve production and profitability in a sustainable manner whilst encouraging the growth of native flora and fauna.
- Improvement within the resource value of the landscape that exposed the importance of landscape value especially for the public. Landscapes are valued by their monetary value; but these case studies aimed to explore the real value of amenity for the public in alliance with eco-services. How much are landscapes really worth? What is the real cost of it (environmentally, economically and socially) to the region? And could it be used as a model for the policy makers (council/government) of NZ.
- On average it took 10% more money to build sustainable industrial sites when compared with a typical industrial complex, but they are built in a way that replenishes, restores and nourishes the on site and surrounding environments.
- Design interventions and changing management practices can be motivated by desires to develop ecological conservation projects that are interwoven with agricultural uses to enhance biodiversity within agricultural landscapes.

Case studies along with analysis of quadruple bottom line issues, allowed development of a research analysis table of the positive and negative issues linked to existing broiler shed farm sites (fig.6).

	Quadruple Bottom Line Analysis							
Issues	Environment		Economics		Social		Animal Welfare	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Health								
Handling								
Stock densities								
Air temperatures								
Transportation								
Size								
Biodiversity								
Pollution								
Waste management								
Gas emissions								
Profit								

Fig.6

This table provided an in-depth analysis of how quadruple bottom line issues impact on the main issues of intensive farming, those being health, handling, stock densities, air temperature, transportation, size, biodiversity, pollution, waste management, gas emissions and profit. The table allowed the analysis and comparison of these issues and established a comparative benchmark for testing the outcomes of the design model in shifting negatives to positive. The coloured boxes indicate whether the issue has a positive of negative impact on the quadruple bottom line issue.

Further development of this table identified landscape design interventions that could inform the design model to mitigate most, if not all negative aspects of intensive farming. They included livings roofs, swales/rain gardens/wetlands, vegetation, amenity, structural layout, micro-climates and eco-services.

These landscape design interventions were then used as a tool to explore ways to address these negative aspects of intensive farming through the model case studies (fig.7).

	Design Intervention Opportunities to address Quadruple Bottom Line Issues						
Issues	Living roofs	Swales/rain gardens/wet-lands	Vegetation	Amenity	Structural layout	Micro-climates	Eco-services
Health							
Handling							
Stock densities							
Air temperatures							
Transportation							
Size							
Biodiversity							
Pollution							
Waste management							
Gas emissions							
Profit							

Fig.7

Living roofs: Improve the water quality by reducing particles and pollution, retain water by way of storage or slow release and; reduce the water quantity through evaporation and plant uptake. In intensive farming situations they could potentially improve the air quality and smell as plants capture air dust particles, air pollutants and filter noxious gasses.

Living roofs also provide opportunities to increase amenity and green space on these farm sites whilst effectively insulating the buildings reducing the amount of energy required to moderate the temperatures within the sheds. According to research a living roof has the

potential to reduce the daily demand for air conditioning in summer by 75%. And has the potential to reduce waste and cost by prolonging the life of roofs. Along with all the energy and water saving aspects associated with living roofs they improve on site biodiversity with vegetation providing habitats.

When living roofs are combined with solar panels it improves their functionality dramatically by allowing the solar panels to become even more effective at producing and conserving energy. The performance of solar panels is highly dependent on the temperature of the panels and their surrounding air temperature. The general rule of thumb with solar panels is *"the warmer the solar panel, the lesser the performance."* As a result of solar radiation they can heat up considerably. This can be even more impaired with hot roof surfaces. However, by combing the living roofs with solar panels they perform better through the cooling effect caused by evaporation at plant level, reducing the air temperature improving solar panel uptake (Breuning, 2012).

Rain gardens/swales/wetlands: Rain gardens are a planted storm water device that removes sedimentation and contaminants through infiltration and storage. They have the ability to remove particles of larger sizes and the capacity to store water and remove smaller particles. Not only do they remove pollutants they also slow down the velocity of water before it flows into surrounding pipes, drains, streams and harbours. Rain gardens have more potential than the commonly used swales as they up take more pollutants and could potentially filtrate the water collected from the washout of the sheds between batches of chickens.

Vegetation is another element within all of these devices that aids in the removal of sedimentation and contaminants and reduction of water velocity through root uptake and transpiration. Planting also provides more biodiversity within sites when combined with the correct selection of plant species.

Vegetation: Has a huge role in increasing biodiversity and amenity. It improves ecological connections throughout the region of which intensive broiler farms are situated. Ecological functions the plants introduce to the area and farms are of the greatest importance for intensive farming sites and their regions.

To ensure New Zealand's biodiversity is improved plant species that entice pollinator's onto sites need to be utilised. Pollinator numbers throughout the world have been decreasing immensely through loss habitat, disease impacts of introduced species on pollinations systems and the use of pesticides. By ensuring plant selection entice pollinators ensures the increase of native insect and animal species (like birds) throughout intensive farming sites and ensures the survival of native plant species through pollination.

Amenity: Enhancing amenity can improve biodiversity, aesthetics, provides a feeling of structure and 'cues to care' for the public, the value of the property and; reduce the running expenses.

Infrastructure: Improving the layout and function of the infrastructure within intensive farming sites improves the value, amenity and functionality of the site.

Micro-climates: Micro-climates are defined as the climatic environment of a very local area, i.e. north or south facing slopes of certain areas within a garden or landscape that differ in temperatures from other areas. They contain atmospheric factors that differ from the macro-climate because of uneven terrain or plant cover. They have the ability to prevent frosts, by planting hedges in the right spots by deflecting the air around them. By creating micro-climates and seasonal micro-climates outside of the sheds through multilayered gardens, living roofs, rain gardens, wet land and strategic planting the design model improved the living environments for the chickens within the sheds. (Croker, 1956).

Eco-services: Eco-services are defined as tangible and intangible benefits that are obtained from ecosystems to provide goods or services for mankind. By employing eco-services in the design model the sites provide benefits for the environment like *habitats, increase in species, carbon sequestration, nutrient cycling, pollination and microbiological processes that begin food networks.* (Misni, 2010)

Research into the Quadruple bottom line issues also highlighted the need to approach intensive farm design in a systemic manner, so the below systems approaches were researched:

Cradle to cradle: Aims to "*harness and maximize local natural energy flows"* (p31, McDonough, 2002). Intensive poultry farm design and development often ignores natural and cultural (or animal welfare) diversity, which results in environments with less variety creating homogenous landscapes. To prevent anymore unnecessary harm to natural environments considerations need to be taken into their typical building process that scrapes away the ground to reveal a bed undisturbed soil, removes trees and vegetation that destroys habitats for natural fauna to erect intensive farms with little or no regard to the environment around it. The designers rarely take into consideration how "*sun might produce heat for the* intensive farm *or how trees could provide protection from wind, heat and cold and how soil and water health can be preserved now and for the future*" (p33, McDonough, 2002).

Agriculture typically creates mono-cultural landscapes that benefit only one species and deplete soils of nutrients and saturate them with chemicals. It is because of this people generally don't want to live near them because of chemical runoff, smell and other effects of farming. Agriculture has drastically reduced the rich network of services causing side effects in which the entire complex ecosystems are replaced with relatively un-complex man made ones and this intensive farming design model mitigated these issues. (McDonough, 2002)

ZEB (Zero Energy Buildings): According to Torcellini, Deru & Crawley (2006) *"A zero energy building (ZEB) is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies."* This concept aims *"to construct buildings that can meet all of their energy requirements from low cost, locally available, non polluting, renewable sources. This means a ZEB generates enough energy on site to equal or exceed its annual energy use."*

This design model is an energy efficient model that reduces energy costs by moving towards on-site or locally generated power. New Zealand is unique in a way as renewable resources like hydropower provide most of our electricity. However our systems are often put on warnings when the levels of our lakes are low, meaning fossil fuels are

depended on to pick up the slack. By using on-site solar generation this model reduces the dependence intensive farms have on power systems.

Permaculture: Permaculture provides us a way to design our lives and environment using ethic as a starting point. The word is derived from Permanent and Agriculture and the understandings came out of the ecology movement in the 1960's when the generation was dissatisfied with the direction people's lives and environment were taking.

Bill Mollison and David Holmgren wrote down things they saw happening in natural forests. Although forests never remained the same, they had lasted thousands of years and stayed. The things that they saw happening quickly became the foundations for Permaculture. (Baxter, 2008)
Their findings of the natural forests included:

- Ever changing ecosystems.
- The natural ecosystems were made up of thousands or millions of elements.
- Every element, plant, tree, animal, insect, trees etc are doing many things within the ecosystem and diversity is essential for continued survival.
- Every element is supported by other elements.
- Within every ecosystem there is zone patterns (areas that different elements have adapted too).
- These systems can survive and change without external help.
- There is no pollution and they have zero waste.

Intensive broiler farms are located within the rural districts and although they are a form of income for the owners, the properties are mainly utilised as lifestyle blocks. By applying the permaculture approach to the sites, allowed it to be divided into zones that addressed the quadruple bottom line issues of intensive farming by acknowledging the economic, social, environmental and cultural aspects of the site. This also exposed another issue with the Auckland site. The existing design proposed six sheds, although this scenario was more economical for the site it impacted highly on the other 3 quadruple bottom line issues, so it was more appropriate to limit the site to 4 sheds.

Industrial Ecology: Attempts to provide a new conceptual framework to understanding the impacts industrial systems have on the natural environment. It aims to implement strategies that reduce the environmental impacts of products and processes associated with industrial systems and it has the ultimate goal of sustainable development. (Garner et al, 1995)

It studies the physical, chemical and biological interactions and interrelationships within and between industrial and ecological systems. It also involves identifying and implementing industrial systems that emulate ecological systems. (Garner et al, 1995) The impacts industrial regions have on the environment are systematic so they require a systems approach that continues to connect industrial practices, human activities and; environmental and ecological processes. The systems approach also provides a holistic view of environmental problems, identifying and exposing problems that need to be solved. (Garner et al, 1995)

The overall goal of industrial ecology is to stop the lineal nature of their systems that use raw materials, products, by-products that produce waste. The poultry industry already reuses waste products from other industries but could further integrate with other industrial systems to optimise the use of waste and by products from other systems, leaving overall zero waste. This allowed for the development of metabolisms of an existing broiler shed site and the design model. Comparison of the metabolisms (fig.8)

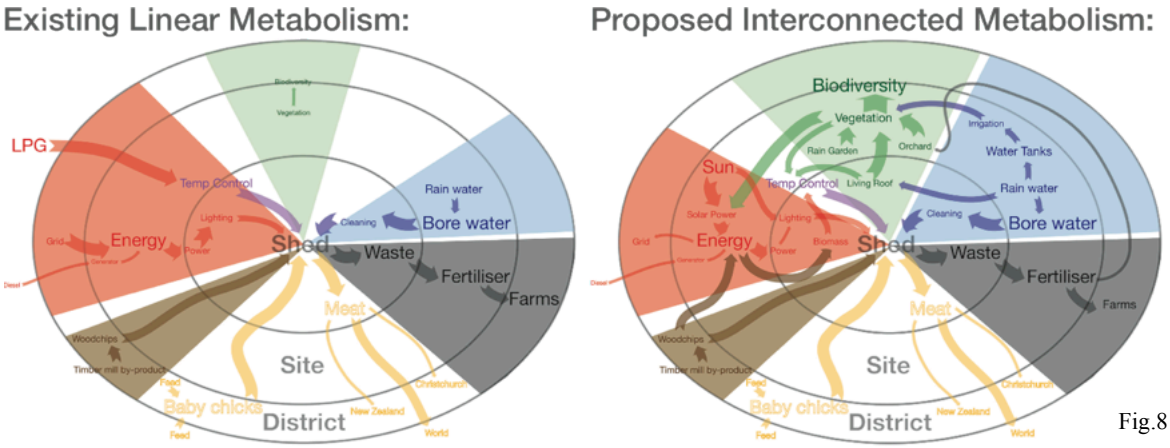

Fig.8

highlighted the lineal metabolism of existing farms when compared with the design model's metabolism that reduces the inputs and outputs and metabolism footprint of the farm site. The design model achieved a major shift to inputs and outputs being retained within the site and shed zones, thus creating a system that works within the site rather

than relying on significant external influences. All external inputs still required come from waste produced in other industries, creating an overall closed circled industrial system.

Analysis of systems approaches, quadruple bottom line issues (environment, economics, animal welfare and social), case studies and existing broiler farming defined criteria for the design models. These models employed landscape architectural design methodologies to create an intensive farm that achieves the goal of improving quadruple bottom line issues.

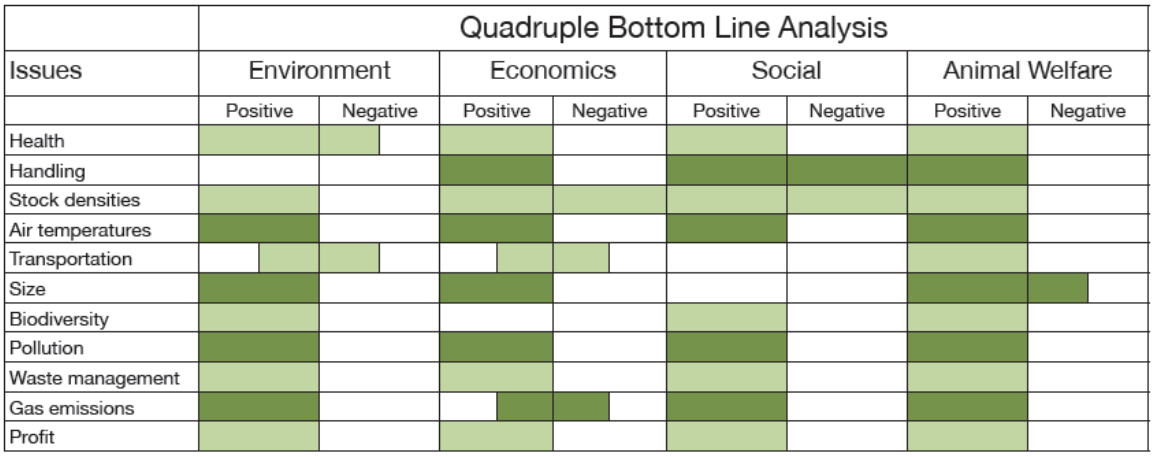

Fig.9

Reassessment of the positives and negatives table exposed the changes the design model achieved in terms of sustainability improvements. Clearly by utilising eco-services within the design model most negative aspects shifted into positives (fig.9).

Summary

NZ has a strong agricultural history that has shaped our nation structurally and socially helping form NZ into the nation that it is today (Cross, 1990). According to the Selwyn District Council about 90% of NZ insects, 80% of trees, ferns and flowering plants, 25% of bird species, all 60 reptile species, four remaining frogs and two species of bat, are found nowhere else on earth. This is remarkable internationally; Britain in contrast has only two endemic species, one plant and one animal. Although NZ is dependent on our agriculture sector, NZ has also become highly reliant on our tourism and filming industries for our pristine, unique, natural environment. If our farming methods continue to negatively impact our environment these economic sectors will be adversely affected. Farming needs to start *"Working with intensification to identify environmental and social gains at the same time as capturing economic efficiencies* as this *is more likely to support*

biodiversity than simply attempting to stem or reverse intensification" (Moller et al, 2008). This design model proves that it is possible to farm intensively in a sustainable manner that improves the welfare of the animals and continues to provide safe, healthy food

Irrespective of whether it is through organic or non-organic approaches, the food demands of the world require more intensive approaches to farming and this does not necessarily equate to non-sustainable approaches. Intensive farming will be required to feed the world and the real question to be answered is how can the poultry industry make intensive farming a positive and sustainable contributor to the supply of food?

NZ has a high dependence on Agriculture for employment and exports and landscape architects have had minimal or no input into the design of farms. There are complex issues surrounding intensive farms with animal welfare being one of the main issues. This highlights the importance of implementing landscape design interventions in a systematic manner to achieve a design model that improves quadruple bottom line issues.

"One of the main concerns with farming has been the degradation of natural resources, including soils, water and biodiversity in and around agricultural land. These trends not only do social harm, but also undermine productivity. This in turn contributes to food insecurity, which affects some 800 million to 1 billion people worldwide." (p269, Thrupp, 2000). This design model could potentially solve these issues with sustainable farming practices that improve interconnections and profitability of intensive farming sites whilst successfully mitigating the on-site issues of intensive farming providing positive impacts for the surrounding communities and biodiversity. It also has the potential to be developed in stages that could revolutionize the poultry industry. The movement could simply start with the design and correct placement of vegetation throughout all existing farms as this alone has the potential to save 17-57% on energy consumption. This along with the correct placement of sheds could also be used as a first step when designing new farms to improve the sustainability of the industry.

Intensive farming is a complex web of functions and services that contribute to the final meat product and this is a design model that has the potential to deal with each individual site that could be expanded to explore its potential for implementation within all sectors

of poultry farming or even other intensive farming sectors (i.e. pig farming) and free range farms. By implementing this model throughout all sites that are involved within the farming process, the industry could contribute to improved sustainability of meat and food production and arguable more importantly, provide a positive perception of the role intensive farming can play in the sustainable future of the world food industry. This highlights the benefits that can be achieved by involving appropriate landscape architectural expertise in the design of farming sites, a profession that has the ability to work with farm owners to design outcomes that mitigate most if not all negative aspects of farming whilst improving the public perceptions by highlighting the contribution farming (in particular intensive) can make to sustainable agricultural approaches.

Currently the government is initiating the National Science Challenge. This is a movement that seeks to utilise sciences to intensify agriculture to earn more money off the land. Although sciences play an important role in agriculture, by combining sciences with a creative holistic landscape systems approach into intensive farming the industry could achieve even more beneficial improvements to the quadruple bottom line issues of intensive farming.

Helen Clark recently attended the Rio + 20 conference and foresees a future for New Zealand in sustainable environmental management. It is our history and expertise in land based production that could lead the world into sustainable food production. She believes *"you can't deal with the environment if the people are poor and the world is inequitable...you have to deal with these things together"* (McNicholas, 2012).
The development of this design model values the farmers and industry's perspective and ensures continuation of economically viable farms. It creates employment opportunities, improves quadruple bottom line issues whilst assuring the continued supply of affordable meat to the world.

New Zealanders alone consume over 70 million chickens every year, so improved approaches to the production of this meat resource is required. The NZ poultry industry has the potential to lead the world in sustainable agriculture by employing this type of design model to achieve positive contributions to sustainability and improved production outcomes in the intensive farming industry.

Food Landscapes, a design model for improved sustainability in intensive farming that encapsulates a smart, profitable design for improved sustainability in intensive farming.

For further reading please visit the full research report at www.lawtonla.com/research/ Food Landscapes

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