Chapter 1 Building a Framework for Research

1.1 Climate change, agriculture and food nutritional security

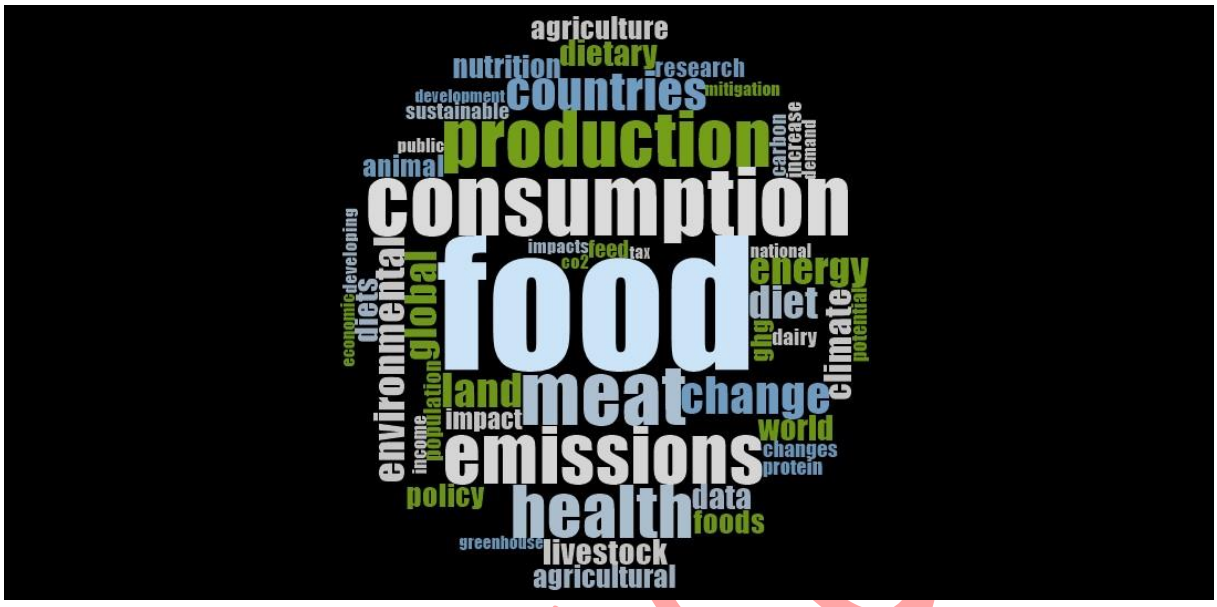

Figure 1. Nvivo word frequency query: top 50 words found in 178 papers reviewed

Concerns around climate change, agriculture and food nutritional security are inter-linked and issues in one cannot be resolved without considering the others. Climate change impacts agriculture and consequently food nutritional security. Moreover, agriculture impacts climate change, contributing 35% of anthropogenic CO2 (Foley et al. 2011) thereby constraining the ability of agriculture to meet projected demand to 2050 (FAO 2006). Agricultural production thus finds itself under increasing pressure to meet the food demands of a growing population as well as reduce its impact on the landscape, environment and climate.

The convergence of a rising world population, expected to surpass 9 billion by 2050, and the onset of climate change means humanity is facing perhaps its greatest challenge (Smith et al. 2013). Food production both relies on and alters the very biological and material world on which it relies (Lang and Barling 2013). Agriculture is responsible for 47% of total anthropogenic methane emissions and 58% of nitrous oxide (IPCC 2007). Moreover, livestock production is the largest contributor to agriculture's carbon footprint, estimated to account for 14% of anthropogenic emissions, with animal feed production/processing and enteric fermentation accounting for 45% and 39% respectively (FAO 2013).

Furthermore, present day farming practices have serious effects beyond contributing to greenhouse gases (GHG's). Of all the land used for agriculture, 80% is given over to livestock production and is linked with mass deforestation; 3 million hectares per year, 70% of which is occurring in Latin America (European Commission 2013). Food production also uses up to 70% of all freshwater (ForumfortheFuture 2015), with livestock contributing most to the sectors associated with water pollution (Alsaffar 2016, Garnett 2013). In addition, modern agricultural methods are implicated in biodiversity loss, soil depletion and degradation (FAO 2006, FAO 2010, FAO 2013, IPCC 2007) such that some (Lang and Barling 2013, Pelletier and Tyedmers 2010) now suggest that agriculture has surpassed the environmental limits in which we live. All of these factors threaten the world's ability to produce food into the future (OECD 2011).

Climate change also directly hinders the ability of agriculture to meet future food demands. It jeopardises the natural resources, water, biodiversity and soils on which agriculture relies and as such may see a material geographical shift in the production of soft commodities (IPCC 2007). Furthermore climate change will result in deteriorating yields in some crops (Alexandratos 2012, European Commission 2013, FAO 2006) and create harsher and more unpredictable conditions for producing agricultural commodities. Therefore, it is imperative that agriculture is included in discussions/negotiations on climate change mitigation and/or adaptation.

Under the United Nations Framework Convention on Climate Change (UNFCCC) Paris agreement, parties to the convention have committed to limit climate change to within 2 degrees temperature rise by 2050. For this to transpire, GHG's must be stabilized within 450 ppm CO2-Eq, or 40% to 80% lower than in 2000 (Stehfest et al. 2009). As a consequence, agriculture is faced with the gargantuan challenge of, increasing food output by 50% to 80% to feed a global population of 9 billion (Keating et al.) under a changing climate and while contending with competing sectors like energy, bio fuels and depleting fossil fuels in a carbon constraint world (Freibauer and Gomis 2011, Thornton 2010)

Problems in agriculture are, more often than not , conceived as issues of production (Garnett 2013). The dominant discourse has focused on production efficiency and "sustainable intensification", (Garnett 2013, Garnett 2014, Lang and Barling 2013). However, it is the combination of both the production and subsequent consumption

that makes food the biggest utilizer of natural resources (European Commission 2013). If we are to meet future demands in addition to reducing agriculture's environmental impact, then demand-side efficiency must also be addressed.

1.1 Demand-side efficiencies and sustainable diets

Studies have shown that without further expansion of agricultural land, most likely to be achieved at the expense of tropical forest and grasslands, current yields will not meet future demand for food to 2050 (Bajželj et al. 2014). Despite measures to 'close the yield gap' by "sustainable intensification", concerns are prevalent that production efficiencies will not be enough and emphasis is accordingly shifting to demand-side options (Alexandratos 2012, FAO 2013, Schram et al. 2013, Steinfeld 2006). For example, recent studies suggest supply-side efficiencies have the potential to reduce global GHG's by 1.5–4.3 Gt CO2-eq. yr~1, while in comparison, demand-side efficiencies could achieve reductions of 1.5–15.6 Gt CO2-eq. yr~1 (Smith et al. 2013).

In tandem with a rising global population and concomitant demand for food, incomes are rising and so too is urbanisation. These conditions are associated with a nutrition transition to 'Western' diets in developing countries (European Commission 2013, Gómez et al. 2013, Hawkes 2009, Hawkesworth et al. 2010, Khoury et al.). Under this nutrition transition to a 'Western' diet utilizing technologically advanced 'Western agriculture' globally would still require twice the amount of land already under crop cultivation (Kastner 2012).

A crucial element of concern in demand-side efficiencies is the associated rise in meat and dairy consumption under the nutrition transition (European Commission 2013, Kearney 2010). Studies accounting for the aforementioned conditions (rising per capita income dependant) and relative to 2009 global diet averages, diets in 2050 will include 31% more ruminant meat consumption, 58% more dairy and egg consumption and 18% less fruits and vegetables (Tilman and Clark 2014). The largest GHG reduction potential associated with diets is in a no-to-reduced meat/dairy scenario (McMichael et al. 2007, Popp et al. 2010, Stehfest et al. 2009). Estimates range from a 2.5GT CO2 to 5.6GT CO2 per year reduction in GHG's in a low meat/dairy consumption scenario (Bailey 2014, McMichael et al. 2007). There are also the positive effects on health of a no/reduced meat and dairy diet emphasising the 'co-benefits' of demand side efficiencies {Bailey et al, 2014; FAO, 2010; IPCC, 2007; McMichael, 2007; Smith et al,

2013}. For these reason, concepts on sustainable diets have come to the forefront of debate in agricultural research.

Consequently, policy-makers face a 'trilemma' of interconnected issues; agriculture, climate change, health and food nutritional security. Policy action that will aid transitions to 'sustainable diets' for health of both humans and the environment is necessitated in developed and developing countries.

1.2 Objectives of the research

Discourse in agricultural research is dominated by production and supply-side efficiencies. However, as will be emphasised in the literature review, demand-side measures have greater potential to reduce the environmental impact of agriculture.

Additionally, research on sustainable diets has focused on developed countries, justifiably given the predominance of unsustainable dietary patterns {Bailey et al, 2014, Garnett, 2011; Garnett, 2014}. However, a deficit in research on developing countries remains {Garnett, 2013; Garnett, 2014; Garnett, 2015}. Growing populations, rising incomes and urbanisation are the main drivers of the 'westernisation' of diets in developing countries (Hawkes 2009). Although over-consumption prevails in developed regions, the largest growth in meat/dairy consumption is expected to occur in emerging economies, as is currently evident in China and Brazil {Vranken et al, 2014}.

However, ethical concerns and sensibilities arise when advising reduced consumption of meat/dairy in countries that often suffer from the 'dual burden' of malnutrition and over-nutrition (Gómez et al. 2013, Hawkesworth et al. 2010, Imamura et al. 2015). Nevertheless, developing countries display the greatest potential for behaviour change once they become aware of the environmental and health issues of meat/dairy consumption {Bailey et al, 2014}.

Subsequently, the objective of this research is to develop national diet guideline scenarios that show the potential GHG savings & health co-benefits in transitioning to sustainable diets in comparison to a business as usual (BAU) scenario to 2050. The emerging MINT economies, Mexico, Indonesia, Nigeria and Turkey, will be the countries of focus.