Postnormal thinking: The need for a better understanding of what oil vulnerability will mean for Australian agriculture

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Abstract
Industrial agriculture uses fossil fuels for the production, processing and transport of agricultural commodities enabling significantly increased volumes and diversity of food/products and markets. Whilst a proportion of this is post-farm, with four tenths consumed at the household/supermarket level, the integrated systems of industrial food production binds the farmer to the consumer via long-chain production and supply systems as well as global economic markets. It is likely that our global economy will begin to feel the supply pressures as stocks of conventional and non-conventional as oil decline (and climate) challenges lead to the constraints on their use later in this decade or early in the next. This will have economic impacts either side of the farm gate. The resilience of the production methods and long chain systems in modern agribusiness to oil shocks and prolonged price increases/fluctuations has not been adequately researched and could present significant risks to the viability of current rural production and communities. It would make for prudent risk management for there to be a dedicated program of research that better understands energy use in agricultural production, including agronomy, which identifies possible risks and considers how to build resilience into Australia's food and fibre production systems. This knowledge could become both economically and societally very valuable**.**

Key words
Rural, peak oil, oil vulnerability, agriculture, agronomy, policy failure, governance, research.

Introduction
It could be argued that in terms of the emerging impacts of climate change and energy we are entering the period of the postnormal, described by Funtowicz and Ravetz as where, "… facts are uncertain, values in dispute, stakes high, and decision urgent" (Funtowicz, 1993). For example, we have built a complex society, even a civilization, based on ever increasing access to a hydrocarbon rich, flexible and scalable energy source drawing from (and returning waste to) an increasingly degrading environmental sphere; which is altering existing energy transitions and flows. The notion of limits by the very nature of our expansion requires recognition of that postnormal world and the development of thinking and science to better inform our adaptive responses (Sadar, 2010; Montuori, 2011). The capability to frame serious consideration of research around agriculture and rural communities within a postnormal framework that takes a risk based approach is one of the major challenges facing us in terms of effective governance and policy (Poldy, 2003).

Method
This paper aims to act as a discussion paper to introduce the topic of energy use in agriculture, oil vulnerabilities and economic and social ramifications. It is built out of my Masters Research thesis, *Peak oil and oil vulnerability: what are the implications for industrial agriculture and rural communities?*, which included a case study based in the southern gulf region of Queensland, and looks at the situation around possible constraints to the supply of conventional and non-conventional oil, implications arising, the Australian policy context and then identifies the broad areas of possible research and development. It raises the risk of inadequate understanding of energy vulnerability for agriculture (and agronomy) and the lack of a research focus based around the depletion of oil as a primary energy input to agriculture.

Oil vulnerability
To date we have seen close to a decade of plateauing of production, with both high and low oil prices acting as both incentive and disincentives for the development of new fields. Whilst an upturn in discovery and production of non-conventional oil has occurred, given the IEA estimates of the conventional oil peak (2006) and decline of already discovered oil, the continuation of the plateau of is unlikely in the longer term (International Energy Agency, 2010). Estimates of the potential date(s) for the roll-over, being the point where conventional oil supply can no longer be maintained, generally sit within a band between 2010

to 2020 (Coventry, 2014, P.16.). A recent study by the Energy Watch Group sees a rollover somewhere between 2015 and 2020, with world oil production declining by 40 percent by 2030 (Zittel et al., 2013); with an estimated annual depletion rate of around 4-6% (International Energy Agency, 2011). Given the possible correlation of energy use to GDP this could pose significant economic and social risks (Ayres and Warr, 2010; Kumhof and Muir, 2012). New technology and methods have allowed for the significant further resource development of unconventional oil and gas fields, particularly in the United States of America, however analysis points to this resource growth peaking and going into rapid decline sometime around the latter part of this decade (Hughes, 2014). Even though the timeframes and rates of decline will be impossible to accurately predict given geography, geology, geopolitics and economics, we can be certain that decline will take place and given agriculture's reliance upon fossil fuel inputs this event will have significant implications for both agriculture and rural communities.

Energy use in agriculture

Whilst we have seen the development of alternative and boutique farming methods and markets, especially in southern Tasmania, the majority of agricultural production in rural Australia is still engaged in larger scale industrial agriculture (Barr, 2005, ABARES, 2015). Food production, in western industrial systems, relies upon the input of fossil fuel for the production, processing and transport of agricultural commodities. This has enabled greatly increased volumes and diversity of food/products, and facilitated the development of a wider mechanism and structure for distribution to global markets that offers to consumers a vast range of commodities, ignoring externalities, at relatively cheap prices. The introduction of chemical fertilizers, insecticides, plant genetics and the development of mechanisation have enabled farmers to increase production via scale, crops, harvesting and mechanical transport. Beyond the farm gate an industry of processing has turned that farm output into a wide array of products, process and markets. Whist a proportion of this is post-farm gate, with upwards of four tenths of this consumed at the household/supermarket level, the integrated systems of industrial food production binds the farmer to the consumer via long-chain production and supply systems as well as global economic markets. So dependent modern industrial agriculture become on energy that it requires an input of between seven and ten calories of fossil fuel input for every calorie of food produced (Pimentel and Giampietro, 2008)**.** Knowledge of energy use in agriculture is generally well understood but it is almost universally taken as a given, is viewed in isolation and not considered in the context of either its wider role in maintaining an industrial system or in the context that energy costs or availability may change. If energy transition is considered it is usually in the context of response to climate change. Energy usage in agriculture is only a component of factors for change and development in agriculture, which will be also driven by economics, political philosophy and technology. Farmers have adapted to changes and hydrocarbon use, both in the use of new products but also in response to increased energy costs. Sloan et al point out that often in response to increased fuel prices US farmers have switched to more efficient methods, that Australian data is too aggregate to "…reliably describe similar trends…', but conclude that parallel energy efficiencies are likely for Australian farmers (Sloan et al., 2008, p.7; Miranowski.J., 2005). However the possible rate of change in hydrocarbon based energy supply could present difficulties for farmers, food security and rural communities. For example my research pastoralist interviewed reported that they felt that significant increases in the price of diesel could make their businesses unviable (Coventry, 2014, P. 61-63.). It is reasonable to conclude that given a consistent period of advances in energy efficiencies in mechanics, processes and production that diminishing returns on the current agricultural systems could be expected.

Implications for agriculture and rural society

The evolution of the current energy dense model and systems has taken place over decades and has, via a neoclassical economic framework, built in energy and structural mechanisms that will face significant challenges operating at higher energy prices, lower energy profit ratios or circumstances of shocks or shortages. These can range from fuel and fertiliser supply issues, vulnerabilities in long chain systems, failure of markets (existing and emergent), increased debt vulnerability, distance, isolation and service provision and a range more beyond the scope of this paper to identify. Rural communities have seen the centralisation of services, the decline of rail transport and the reduction of population beyond regional centres. The resilience of the long chain systems in modern agribusiness to oil shocks and prolonged price increases has not been fully researched and presents a significant risk to the viability of current rural production (Sloan et al., 2008). Any shortages of, or significant increases in the price of, fuels and feedstock (fertilizers and pesticides) could hurt rural production and rural communities directly. For example analysis by Sloan et al has identified that possible changes due to oil vulnerability may bring about the following changes: (a) to the distribution of agricultural types within Australia's regions; (b) to the intensities of agricultural land uses; (c) shifts in the primary mode of transportation of agricultural products, such as from road to rail; (d) restructuring of settlement patterns – concentration or dispersal – as communities adapt to higher transport costs; and (e) abandonment of some land types or sub-regions if production and transport costs became prohibitive (Sloan et al., 2008 , p.11). This challenge is not limited to established industrialised agricultural systems, for example the dependence of developing countries, such as China (Smil, 1991, p.586), on increasing fertiliser use to feed ever increasing population growth (Giampietro and Pimentel, 1993).

Policy avoidance

Whilst there have been limited attempts to raise the issue of oil vulnerability into the political and policy discussion spheres there has been an unwillingness to openly consider what the implications for Australian society may be. This tension has in part led to "… a petroleum security policy stasis in which obscuration or deferment of problem acknowledgement substitutes for the formulation of a response" (Dodson and Sipe, 2010, p.294). For example, at the time of writing, the Agricultural Competitiveness Green Paper contains one small line on energy security, being that the, "… Government will consider Energy Security, which may impact on Australia's food production, in the context of the Energy White Paper", with the final Agricultural Competitiveness White Paper is completely silent on energy risk (Department of Agriculture, 2014, P. 109; Department of Agriculture, 2015). The 2015 Energy White Paper is also silent upon both our rapidly diminishing indigenous conventional oil supply and upon any analysis of future global supply trends, either positive of negative, rather looking towards the analysis of the 2011 National Energy Security Analysis which sees no supply challenges out to 2035 (Department of Industry and Science, 2015). It is this failure to consider and analyse emerging risk that increases vulnerability and limits measures for either mitigation or adaptation. This places policy development in a weakened position, in a complex and often misaligned or crowded planning framework where issues and policy responses compete, cancel or confuse appropriate development. Academic research and community input can inform policy settings, as is with the increasing peer reviewed papers around peak oil, however both research and policy development can be supressed or hindered by a lack of, or even hostile, philosophical environment within government departments (Steele and Gleeson, 2010). Public servants and policy writers may have to wait for clear authorising environments to begin to even broach difficult topics. Until appropriate signals for research and policy development are available, Australia will be at increased risk of planning failure in regards to this event and its ability to effectively implement timely mitigation and adaptation measures.

Research needs

Current analyses of agricultural trends are located within the conceptual framework that cheap and plentiful oil and gas will continue and is almost the universal default position for both research and policy discussion. Any new work in relation to this issue is limited and exploratory. Research that begins to engage with an energy depletion component would mean that we are better informed to make appropriate policy development and improved adaptive responses. Whilst any of the above listed possible changes by Slone et al offer a starting point, baseline analysis of key vulnerabilities in relation to agriculture and rural communities is a solid starting point. These could entail research and analysis of key areas, including:

- energy inputs to and use in industrial agriculture and agronomy,
- what conventional oil depletion would mean for agricultural production and possible adaptation/transition pathways,
- transport and communication options and alternatives,
- how could rural society keep connected, active, engaged and viable in an energy constrained situation, what services and structures will fail and what will need to be replaced or restructured,
- methods for building community resilience and social cohesion.

These are but a small part of what should be an urgent and significant priority for future agricultural research. In general any further research will add in some form to further understanding of what will be, and how we can attempt to manage, that energy constrained and oil vulnerable future. Academia has to date played an undeveloped role in this task with limited work by a range of scattered and committed academics. It is not recognised in Australia in any tertiary curriculum as a key discipline, theme or serious area for either research funding allocation or research. Compared to other key societal challenges, for example climate change, an event of this impact is barely acknowledged and understood. The value of this research is not diminished whether the depletion period or roll-over commences towards the end of this decade or two decades hence. Universities, agencies and research funding bodies that initiate this research will not only be providing an extremely valuable societal good but also will have information, understandings , skills, tools and product that will be globally needed, sought-after and valued. That knowledge generated may assist in the advancement of policy development by creating a pathway for a clearer authorising environment for policy writers which in turn may lead to better governance outcomes.

Conclusion

It is likely that little adaptive response to oil vulnerability will take place until we are truly in the postnormal space of depleting supplies. There exists the need for research and planning frameworks to be established that enable us to actively understand and negotiate those future complexities and challenges and be armed with the best knowledge to inform both mitigation and adaptation pathways. Given modern agriculture's role of assisting in the feeding of our global population such engagement and research should be of the highest priority.

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