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Robustness of Industrial Crops in High Production Cost Agricultural Systems – Dealing with Market Flux

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Industrial or extractive crops are agricultural crops grown primarily for an extractive commodity and are important economic components of many agricultural production systems [1]. They provide novel plant based products for a wide range of uses. These crops are generally regarded as high value per production land area crops and can provide a significant income stream to producers. Furthermore the requirement for additional processing creates additional economic activity, industrial development and associated employment and adds significant value to the saleable products.

Industrial crops can be well suited to agricultural systems in both developing and developed nations. The small size of many small holder farming enterprises in developing countries can make high value industrial cash crops highly attractive, allowing growers to earn superior income compared to traditional staple foods. In developed nations; especially in regions where land prices, labour, fuel and other input costs are high; these crops can be very important components of farming systems providing superior returns per land area unit on farm. The State of Tasmania in Australia provides a classic example of this latter scenario. Tasmania has a strong agricultural sector with diverse production systems in a cool temperate climate. However, Tasmania has a limited area of productive land in comparison to most of the other Australian States and average agricultural land costs are some of the highest in the country. Broad acre production of agricultural commodities is, as a result, less competitive than in other regions of Australia, or indeed when compared to many other major agricultural producing regions around the globe where greater land areas are available. Tasmanian agriculture has been highly active in adopting industrial crops within its production systems. For example, Tasmania produces more licit opiates from opium poppy production than any other part of the world [2]. Similarly Tasmania is the world's largest producer of natural pyrethrins, insecticidal compounds extracted from the pyrethrum plant [3]. Many other niche extractive food and fragrance crops are grown including hops, lavender, *Boronia* and even native species such as *Tasmannialanceolata*, the native pepper berry which produces a spicy extract used in the food industry [4,5]. These crops (and in particular poppies and pyrethrum) provide very important contribution to farming incomes in cropping and mixed cropping enterprises in Tasmania.

The value of industrial crops to communities is not limited to farm profits. Post farm-gate, these crops provide significant economic benefits in agricultural and chemical research and development and in product processing and values adding enterprises. The high crop value encourages investment in production technologies (research and development in breeding, biotechnology, and crop agronomy and harvest technologies) and in infrastructure and processing technologies (logistics, product chemistry, extraction technologies, product storage etc). Development of significant processing infrastructure provides additional employment and financial benefits. For example, the Tasmanian poppy industry, whilst significant as crop in value to farmers, generates at least ten times this value in post-harvest processing of the pharmaceutical products.

However, a major limitation of most industrial crops is the volatility of the markets for these extract products. The majority of niche industrial crops sell their products in global rather than local markets and as such are subject to bust and boom cycles as global production rises and falls. This is particularly evident if extracts can be stored for extended periods post production filling market need as it arises. Highly profitable enterprises will attract new entrants into the industry. Industrial crops provide good examples of this. When supply is short and prices rise, production regions increase. Supply saturates markets and prices fall leading to reduced profitability and participants reducing planting area or leaving the industry. These boom and bust cycles can occur over extended periods (often decade long cycles). To survive the lows, producers and processors need very high efficiencies in place, critical scale and flexibility to increase and decrease production areas. A common model used in Tasmania to accommodate this flexibility is production based on contracting out of production areas by major processing companies with grower contracts renewed and revised as demand rises or falls.

The poppy industry is an interesting example that is buffered to some extent from this cycle. Global production is highly regulated by the United Nations with concerns over any diversion of excess products to illicit markets. Producers must meet stringent standards. However even with protection from an explosion of new industry entrants and area expansions when prices are good, as a globally traded commodity the opiates are still subject to global demands. Indeed in the 2014/15 season there is an expectation that the cropping area in Tasmania may be reduced by 20% reflecting a downturn in demand following the United States government decision to address the perceived overuse of prescription pain medication in that important market [6].

To remain competitive in a global market, production regions like Tasmania with high fixed input costs require technological advancement, production scale and marketing processes superior to their major competitors in lower cost production regions. For example, Tasmania's major global competitors in pyrethrum production are in East Africa (primarily Kenya) and increasingly China. All have lower cost production systems, but Tasmania remains the major global supplier through superior plant genetics, superior productivity particular with respect to disease control, more efficient planting and harvest systems, superior extraction and processing technologies and sophisticated marketing operations [7,8]. In this crop Tasmania also has advantages in scale of production enabling capacity to consistently meet demands through market highs and lows.

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Advancing technology with efficiency improvements can of course exacerbate global supply and demand fluctuations by reducing the requirements for volume of plants grown. For example, hops are primarily grown for their resins, essential oils and polyphenolics extracted from their cones that provide aroma and bitterness to beer [4]. Traditionally hop cones were harvested, dried and pelleted prior to use. These pellets had a limited shelf life and the ratio of alpha to beta acids within the cone extracts was critical to the quality of the product. Advances in breeding enabled higher alpha acid yields reducing the requirement for the number of hop plants globally [9]. Even more profound, new extraction techniques allowed extraction, separation and long term storage of alpha acids reducing the need for fresh seasonally produced cones, allowing product to be stockpiled for market demands. These advances severely affected the profitability of hop production over an extended period with many companies and regions ceasing production. In Tasmania alone only the largest hop producer survived the downturn and production regions were greatly reduced.

The demand for technological advances does not abate as continual improvement in efficiency and productivity is a driver for industry competitiveness [7,8]. It is not a coincidence that the major companies involved in production and processing of these industrial crops are also major investors in research and development both in house and with external providers. Technological "edge" is a critical component of these businesses. For example, breeding advances in Tasmania for both pyrethrum and poppy are being replicated in other production regions [10,11]. Equally important to competitiveness is the capacity to protect the intellectual property around the technological advances providing production and processing efficiencies. Technologies may be patented or are commonly held "in house", and plant genetics may be protected through variety rights or other agreements.

In summary, industrial or extractive crops are attractive industries where high value production per unit farm area is essential. Within a globally marketplace participants in these industries must survival global boom: bust cycles through innovation and development of production and processing efficiencies, market strength and production scale and flexibility.

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