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The Influence of Emerging Artificial Intelligence Technologies on Australian Wheat Markets and Value Chains

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Abstract

In this paper the potential influence that emerging artificial intelligence (AI) technologies will have on both the marketing and the value chain of the Australian wheat industry is outlined. With AI's expanding applications in industries globally, its potential influence and benefits in the wheat industry are significant. Through the amalgamation of data gathered by AI, decisions can be made in all aspects of the value chain with increased information, and therefore reduced risk. Considering the Australian wheat industry's importance in the Australian economy, predicted to be valued at $15 billion in 2022-23, utilising emerging technologies such as AI would seem to be integral to maintaining high production levels. Analysing the potential benefits and challenges of incorporating AI into wheat production systems provides an indication of the opportunities for increased efficiencies.

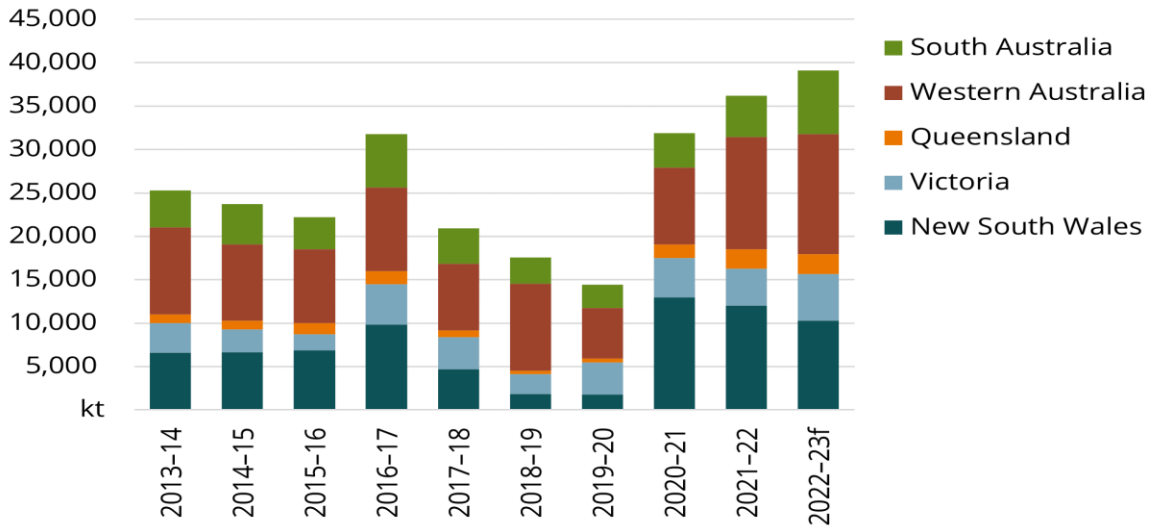
Keywords: artificial intelligence, wheat, value chain, marketing, data analysis

Overview of Australian Wheat Industry

Australia is a major global wheat producer, with the value of production predicted to reach an historical high in 2022-23 of $15 billion, with a predicted 39.2 million tonnes produced. Western Australia is typically the largest wheat production state in Australia, followed by New South Wales, as can be seen in Figure 1. The wet harvest conditions in 2022, combined with cooler spring temperatures resulted in lower average wheat protein levels in parts of Western Australia, alongside South Australia and Victoria. The production value of wheat in Australia is predicted to fall in 2023-24 to $10.7 billion, due primarily to expected lower rainfall levels (Dahl, 2023).

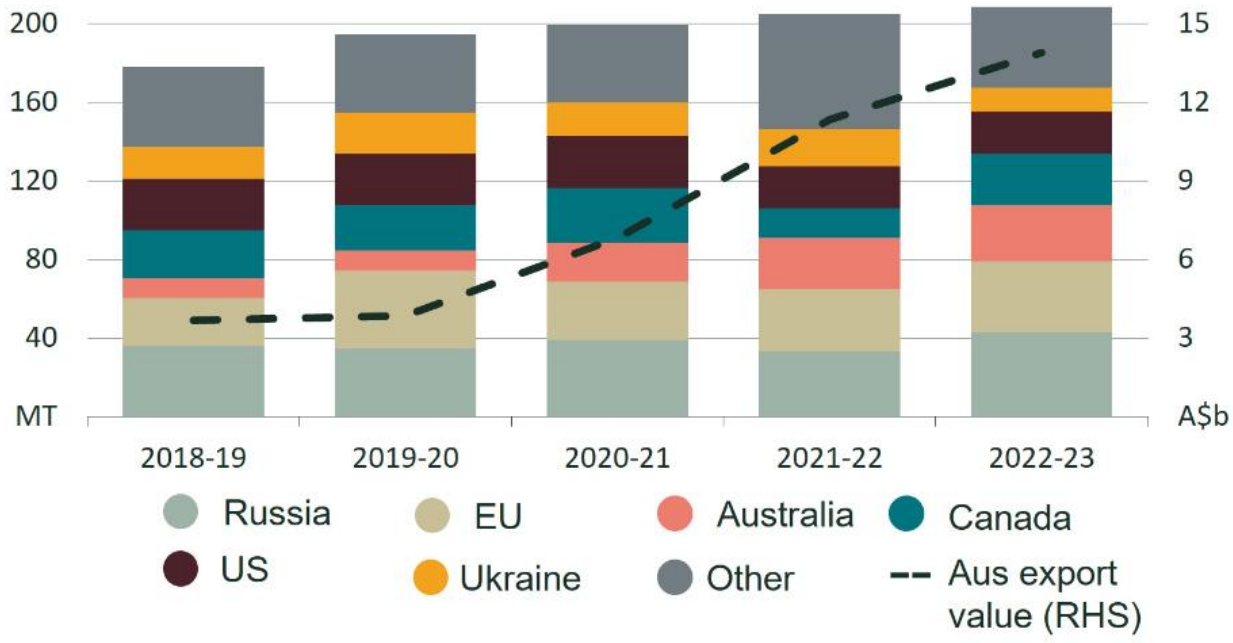
Australia exports large quantities of wheat, with an expected record high in 2022-23 of 28 million tonnes, valued at $14.2 billion. Australia is projected to contribute 13.7 per cent of world wheat exports in 2022-23, as depicted in Figure 2 (Department of Agriculture, Fisheries and Forestry, 2023). This is expected to drop to 22.5 million tonnes (valued at $10.8 billion) in 2023-24. Australia exports wheat primarily into Asian markets, due largely to lower freight costs compared to competitors and a high demand for Australian wheat. There is also elevated demand for Australian feed wheat, due to the current high global corn prices. Lower production in competing export nations such as Ukraine, India and Argentina have also benefited Australian export levels (Dahl, 2023).

Figure 1. Wheat production levels in Australia's major wheat producing states, 2013-14 to 2022-23 (forecast) (million tonnes)



Source: (Department of Agriculture, Fisheries and Forestry, 2023)

Figure 2. Australia's total value of wheat exports compared to world wheat exports, 2018-19 to 2022-23 (million tonnes)



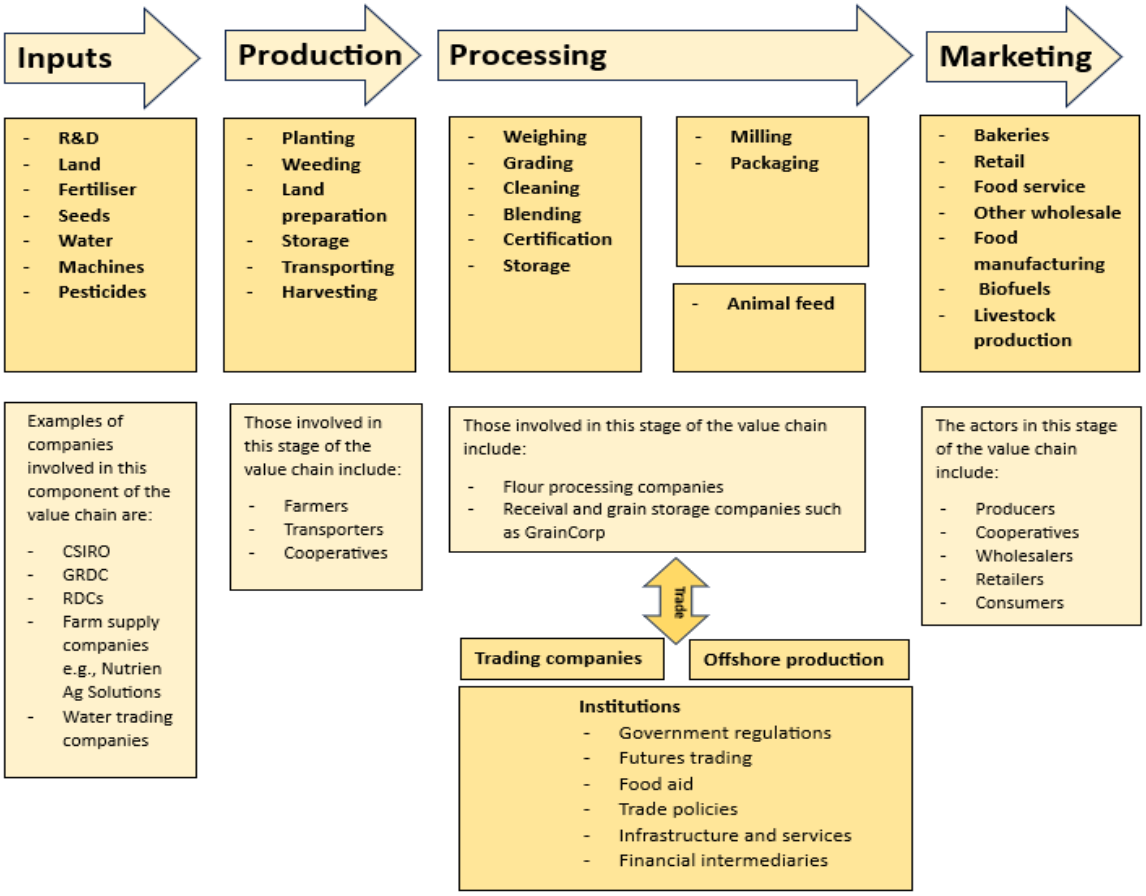
Source: (Department of Agriculture, Fisheries and Forestry, 2023).

World wheat consumption has maintained record levels in 2022-23 and is expected to increase in 2023-24 to 792 million tonnes. Milling wheat demand is expected to increase in alignment with population growth, changes in diets and growing income. The demand for feed wheat will be determined primarily by the production and prices of substitute feed grains such as corn and barley (Dahl, 2023).

Wheat Value Chains and Markets

Australian wheat value chains are complex, with many parties involved. For a value chain to function efficiently, it is important that information is shared quickly and accurately, and that each component of the chain adds value to the product. There are both logistical and cross-functional drivers in all value chains. Logistical drivers are the facilities, inventory, and transportation, while cross-functional drivers are information, product sourcing and pricing (Trivedi, 2022). In the wheat value chain these drivers are crucial to create product, information, and value flow within the chain to maximise efficiency and the consumer's willingness to pay for the product. In complex agricultural value chains, the importance of transparency, traceability, and sustainability with correct, accurate and efficient sharing of information between stakeholders is high, to maintain or build consumer trust. In agriculture, the size and complexity of the value chains creates difficulties in maintaining the transparency of the chain. There are many steps of the value chain which are conducted by different stakeholders, such as transportation and storage. This can result in stakeholders focusing on their individual component of production and a reduction of efficient and accurate communication (Astill, et al., 2019). Through utilisation of AI, this flow can be optimised through the analysis and use of data and collaboration between stakeholders in the value chain. A simplified wheat value chain can be seen in Figure 3, outlining the steps in the network and processes involved.

Figure 3. Wheat value chains, outlining some of the components of each stage and influencing institutions



Source: Author's compilation, from (Ayele et al., 2021; and Duke Minerva, 2013)

Wheat markets exhibit traits common to many agricultural markets: biological features such as defined growth periods and seasonal patterns, the perishable nature of the product, susceptibility to weather fluctuations, and significant price volatility. The markets for wheat are also primarily

competitive and the products are primarily homogeneous. This means that optimisation of the value chain is essential (O'Keeffe, 2017). Through the utilisation of AI, wheat marketing can be optimised, producing the highest profits for the producer and best product for the consumer. This has the potential to occur through different methods, including yield prediction, market forecasting, pricing and risk management.

AI Technologies

Simply, AI is the use of computers to complete cognitive functions typically associated with human intelligence such as problem solving and learning. This can therefore be utilised to resolve real world issues, including problems faced in agriculture throughout the value chain, from production through to marketing (Ryan, 2022). Through the utilisation of AI, the production of wheat can be optimised to meet demand and maximise revenue across the value chain. Use of AI has the potential to increase the optimisation of value adding, assist with managing risk, market forecasting and increase efficiencies in the supply chain through the analysis of data (Vijaykumar et al., 2022).

AI can enhance efficiency throughout the wheat value chain, from production to marketing. By analysing available data and information, stakeholders at every level can make more informed decisions. This optimization extends to relationships among value chain participants, effectively managing various risks associated with wheat production such as yield, climate, market price, supply chain disruptions, and pest and disease risks. This risk mitigation is achieved through improved efficiencies, heightened accuracy, and better decision-making due to increased ease of accessing reliable information quickly and readily, ultimately leading to the potential for increased revenue and heightened consumer satisfaction.

The use of AI can refine production and input efficiencies in the value chain, and therefore increased value can be added to the final product. AI can combine many sources of data to provide current and specific information on the conditions in a paddock at all stages of production. This means that producers can combine this data using AI software to calculate real time revenue for their crops, paddock to paddock. This can include data from sources such as satellites, soil moisture sensors, crop health sensors and weather agencies. Through the accumulation of this data, specific information can be more easily accessed by farmers regarding fertiliser requirement variations in a field, irrigation requirements, precise herbicide and pesticide applications and other input requirements and variations. By combining precision agriculture technology with this information, yields are likely to be improved and inputs reduced (Eli-Chukwu, 2019).

An example of a company utilising the analysis of data to increase information transparency from the production level is John Deere, as demonstrated through their focus on technological advancements. In November of 2020, John Deere purchased ‘Harvest Profit’ which is cost and profit tracking software. This software allows for the tracking of the profitability by field, the cost of production, grain stocks, current revenue, balance sheets as well as grain marketing positions for producers (Harvest Profit, 2023). Through real time analysis of this information, which is combined into an easily accessible source, producers can make more informed decisions. Similarly, sharing of this information with other stakeholders in the value chain can improve the flow of information.

Through the analysis of large data sets using AI, the breeding process for new wheat varieties suitable for specific conditions can also be improved. That is, the selection process can be accelerated using genotype and phenotype prediction (Harfouche, et al., 2019). With increased extreme and variable climatic conditions due to climate change, reduced time to produce new varieties will be of significant benefit. Overall, through utilising the data-analysing capability of AI, it is likely input decisions for

wheat production can be adjusted to minimize waste and increase outputs, ultimately leading to higher yields and greater value added in this stage of the value chain.

The processing of wheat also has the potential to be enhanced using AI, with the algorithms having the ability to analyse information provided by machines used to grade wheat, providing quick and accurate information which is then compared with databases. AI can evaluate characteristics such as protein, test weight and moisture levels of the wheat, which is then used to grade the wheat by comparing the results with the standards provided for the different grades (Inacio Patricio & Rieder, 2018). The company Super GeoAI Technology has produced an app which utilises AI to grade wheat using a mobile phone, having the potential to reduce costs and time in the grading process. As this is a new technology, accuracy may not be as high as traditional wheat grading processes (SGA.ai, 2023). With increased difficulty in finding staff willing to work in rural locations, the implementation of AI could assist with overcoming this challenge and reduce labour requirements and costs (Inacio Patricio & Rieder, 2018).

AI also possesses the capability to identify inefficiencies and holdups in production, and therefore improve production efficiency. The processing of the wheat could be refined by examining data from sensors, which can monitor variables such as processing time, temperature, and humidity. This means they can be adjusted instantly based upon the data analysed, and therefore energy usage and waste can be reduced, and the overall efficiency increased (Misra, et al., 2020).

Alongside the potential of enhanced efficiency in the production and processing of wheat, AI demonstrates the opportunity to improve wheat marketing through prediction of yield. The ability to predict wheat yields is important for the wheat producer, but also for global food security, allowing for increased capability to respond to food production levels and price volatility. AI has the capacity to combine information gathered from statistical models, remote sensing, crop models and field surveys, and use mathematical algorithms to predict crop yields (Lim, 2022). Through combining and analysing data from various sources, AI can improve market forecasting and pricing. AI is capable of identifying and analysing patterns in historical data which may not be clear to human analysts. This would allow for a more accurate forecast of wheat demand, supply, and prices. Combined with weather forecasting and yield predictions, AI has the ability to provide an indication of likely price fluctuations due to varying global crop yields. AI can also analyse consumer trends through sources of data such as social media and other media sources, which can provide an indication of demand and trends in the market (Rakhra, et al., 2022). This can benefit the marketing of wheat, through optimising supply to meet demand alongside increasing the ability of producers to forward plan through the accumulation of data quickly and specific to the requirements of the stakeholder. The ability to forward plan improves coordination in the value chain, ensuring that the supply meets consumer demand. As wheat markets are competitive, there is little flexibility to adjust to consumer demands quickly, and therefore through analysing trends and predicting demand ahead of production and processing of wheat, delays or a reduction in the expected quantities processed can be avoided. This means that value chain profit and consumer satisfaction can be maximised. If forward planning does not occur, a reduction in demand can mean that increased costs are incurred in storing the wheat, and the processing facilities are not being used effectively. By increasing transparency in the amount of wheat moving that will be moving through the value chain, increased efficiency can occur.

Risk management is another factor in wheat marketing where AI can be used to benefit wheat value chains. AI can collaborate information and data to analyse market risks and therefore provide assessments and risk mitigation strategies. This can be done through analysis of potential or current weather and climate related influences on production and distribution, political factors throughout the globe and their influence, alongside global financial influences (Moosavi, et al., 2022). These all impact the price volatility of the wheat market, and therefore through analysing shifts and potential

anomalies, information can be accessed quickly and easily by stakeholders in the value chain, meaning more informed decision making can be conducted with increased ease.

Challenges of Integrating AI in Wheat Value Chains and Marketing

While there are clear benefits from utilising AI to improve both the value chain and marketing of wheat in Australia, several challenges will have a significant influence on adoption. The availability of data is the biggest drawback, with a lot of agricultural data being outdated or unavailable (Eli-Chukwu, 2019). The cost of implementing AI into systems can also be very expensive, and therefore is not accessible for many. The process of farmers adopting new practices and technologies often requires time, typically requiring evidence of the benefits before embracing these changes. While there are many producers who are more responsive to changes and will embrace new technologies such as AI quickly, those who are more conservative with their practices are likely to be slower with their uptake. Despite this, the value-adding potential that AI technologies offer will likely encourage swift adoption of practices which incorporates this technology (Mohr & Kuhl, 2021). For an optimal increase in efficiency across the entire value chain, widespread adoption of AI technology by all involved parties is required. Nevertheless, even as the adoption of AI technologies occurs gradually at different stages of the value chain, there will still be noticeable improvements in wheat value chains.

AI relies on the availability of large datasets, especially at the producer level where effective coordination is essential. Many companies and institutions in agriculture are equipped to provide the coordination of this data collection and management such as John Deere with the purchase of Harvest Profit, and with the development of apps by companies such as Super GeoAI Technology. However, many agricultural companies are not yet at a level of technological advancement where the coordination and efficiency of data collection for AI's potential to be maximised are possible. Similarly, as mentioned, the purchase of equipment with technology to support the collection of data is expensive, and this is not a cost which will be affordable for many at the production level. Without collection of data from a broad and large number of sources, the information produced is likely to be inaccurate (Eli-Chukwu, 2019). Therefore, the primary challenge lies in coordinating the efficient collection and management of data, a prerequisite for AI to fully optimise these opportunities.

Despite the challenges and work that still needs to be conducted, there is immense potential and results are already being observed for the ability of AI to improve the marketing and value chain efficiency in the Australian and global wheat industry.

Conclusion

There is significant potential for increased efficiencies through the integration of AI into wheat value chains and marketing. While the integration of the technology still needs to occur in many aspects of the value chain, and adoption may initially be slow, the long-term adjustments to the industry through AI use appear to be positive. Through increased sharing of information and data accumulation through AI analysis, risks can be managed, consumer demands met, and efficiencies increased.

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