

“粮食产业链数字化和创新技术研究” 特约专栏文章之三

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# 澳大利亚粮食供应链数字化与创新机遇（中英文）

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**摘 要：**澳大利亚粮食产业是国民经济的重要支柱，其以规模化生产体系、多样化作物结构、高效供应链管理和严格质量安全标准著称，但在数字化转型浪潮下面临现代化升级压力。该产业国际声誉的建立，植根于完善的行业规范体系、标准化生产流程及对环境-社会-治理（ESG）原则的深度实践，其中澳大利亚粮食贸易协会（GTA）在标准制定与行业协调中发挥核心作用。本文通过三维度展开论述，首先解析澳大利亚粮食供应链的运作特征、竞争优势及声誉维护机制，揭示其核心竞争力形成路径；其次论证数字技术创新对提升供应链可追溯性的赋能效应，着重探讨技术应用价值与实践路径，同时剖析面临的四大现实挑战：数据治理复杂性、技术系统碎片化、商业物流协同障碍及消费者信任构建难题；继而系统提出应对策略；最终从效率革新、安全强化与绿色发展三维视角，研判供应链现代化转型的战略机遇，并展望产业演进趋势。以期提升澳大利亚粮食供应链运行效率、保障产业可持续发展提供实践参考，助力该国在全球粮食市场中保持竞争优势。

**关键词：**澳大利亚粮食产业；供应链；数字和新技术；措施

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## Opportunities for Digitalization and Innovation in Australian Grain Supply Chains (Chinese and English versions)

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**Abstract:** Australian grain industry is a significant to Australian economic, characterized by high production capacity, large scale, crop diversification, efficient supply chains and focus on quality and safety, but it is currently and continuously seeking to modernize. The Australian grains industry's positive reputation is

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本专栏背景及作者介绍详见 PC6-12，本文英文原文详见 P41-46。

supported by a range of industry codes, standards and environmental, social and governance (ESG) concerns, facilitated by the Grain Trade Australia (GTA) led industry self-regulated framework. This article provides an overview of the Australian grain industry supply chain, including its characteristics, advantages, and key measures that uphold its reputation. It elaborates on the role of integrating digital and innovative technologies into the supply chain to enhance transparency, covering the importance and applications of such technologies, as well as challenges such as complex data governance, technological fragmentation, and commercial and logistical barriers. The article outlines strategies to address these challenges and analyzes opportunities for supply chain modernization in improving efficiency, ensuring safety, and advancing sustainable development, while offering insights into future prospects. The aim is to provide a reference for ensuring the efficient and sustainable development of the Australian food industry supply chain, and further maintain the global competitiveness of the Australian food industry.

**Key words:** Australian grain industry; supply chain; digital and innovative technologies; measures

澳大利亚粮食产业（谷物、油籽和豆类，不包括大米）是该国经济的重要组成部分，年产量超过 5 000 万 t，其中 2022—2023 年度产量更是达 7 080 万 t。该产业超过 70% 的产量用于出口，是澳大利亚农产品出口收入的主要来源。根据 2022/23 年度的预测数据（不含大米），澳大利亚粮食产业实现了历史性的突破，成为该国农业部门中产值最高的产业。数据显示，该年度澳大利亚粮食产业的农场门市产值达到 310 亿澳元，出口值高达 297 亿澳元。这一产业以超过 33% 的贡献率，成为推动澳大利亚农业经济发展的核心力量<sup>[1]</sup>。

近年来，澳大利亚谷物产业展现出显著的发展优势，凭借其强大的生产效能、完善的供应链体系以及对产品质量与安全的严格把控，持续保持强劲的增长态势。与此同时，全球贸易格局的深刻变革给粮食供应链带来了新的挑战，促使产业加速现代化进程。这一转型趋势主要源于三个方面：技术创新的驱动、可持续发展理念的深化，以及国际市场对食品安全和粮食保障的更高要求。

本文综述了澳大利亚粮食供应链的运作方式，强调了数字和创新技术以及供应链现代化在提升效率、保障安全与实现可持续发展方面的机遇，深入探讨了数字化和创新技术如何重塑供应链，以确保效率、可持续性和全球竞争力。

本文综述了澳大利亚粮食供应链的运作机制，强调了数字技术与创新手段在推动供应链现代化进程中所发挥的作用。深入探讨了数字化转型如何重塑粮食供应链，以确保效率、可持续性与全球竞争力，揭示了技术革新在保障供应链安全与实现可持续发展目标方面的重要机遇。

## 1 澳大利亚粮食产业供应链概览

### 1.1 澳大利亚粮食产业的特点

澳大利亚粮食产业以市场为导向，展现出强大的国际竞争力。该产业以供应安全优质的产品而闻名，凭借良好的声誉和可靠的供应链体系，在全球市场中占据重要地位。其供应链网络覆盖了广泛的农场内外仓储设施、铁路、公路和港口基础设施，形成了一个高效运转的物流体系。众多参与者在国内外粮食贸易中积极竞争，推动了产业的持续发展。面对技术与市场环境的瞬息万变，该产业通过实施高效、可靠的安全与质量标准，赢得了全球市场的认可。得益于靠近不断扩展的市场优势，未来几十年，澳大利亚粮食产业将持续迎来市场增长机遇。

此外，澳大利亚粮食产业具有强大的自我监管框架基础。澳大利亚粮食贸易协会（Grain trade Australia, GTA）在维持行业标准、促进贸易、行业管理及提升行业能力方面发挥着关键作用，见图 1。



图 1 澳大利亚粮食产业的自我监管框架

Fig.1 Australian grain industry's self-regulatory framework

澳大利亚粮食种植者以积极寻求和采用新技术、勇于变革的特质而闻名。当前,科技创新正在飞速发展,全球市场对价格亲民、安全可靠且可持续生产的食品、饲料和能源产品的需求日益增长,这为澳大利亚粮食产业创造了长期发展机遇。

粮食产业及其上下游企业,贯穿从农田到餐桌的全产业链,为城市和农村地区创造了大量就业机会。随着国内需求持续增长以及亚洲地区强劲的经济与人口增长态势(自 2000 年以来,亚洲小麦进口量已翻倍),该产业展现出坚实的发展基础和广阔的发展前景。

## 1.2 澳大利亚粮食产业的优势

一是效率高、规模大。粮食种植者富有创新

精神,他们不仅工作效率高,而且乐于采用新方法、新工具和新技术,这使得耕作方式不断演变并能够应对各种挑战。尽管澳大利亚气候干旱且多变,但主要农作物的用水效率和产量仍在持续提高。澳大利亚粮食产业通过运用先进的耕作技术、不断改良基因和采用新技术,实现了每毫米降雨的产量不断增加,达到世界领先水平。

二是作物生产多样化。澳大利亚种植多种谷物、油籽和豆类作物(见图 2)。2024—2025 年度澳大利亚主要作物产量为小麦 2 840 万 t、大麦 1 160 万 t、油菜籽 610 万 t、高粱 210 万 t。2022—2023 年,粮食出口量接近 5 500 万 t,为经济贡献超过 320 亿澳元。

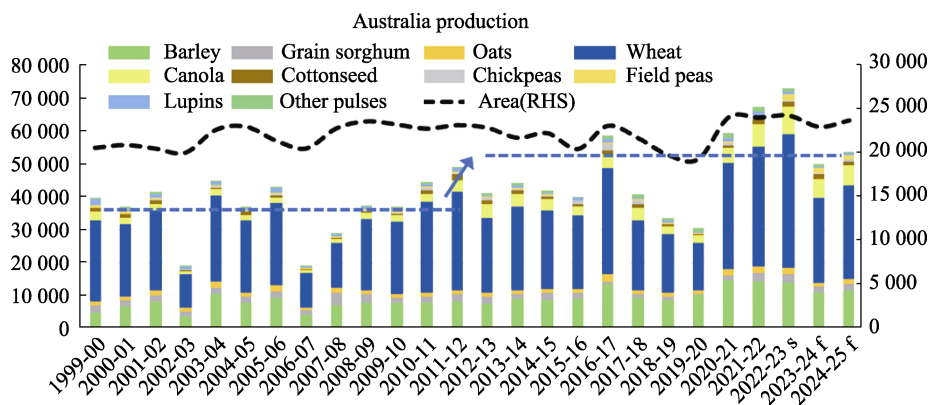


图 2 澳大利亚粮食产量<sup>[2]</sup>

Fig.2 Australian grain production<sup>[2]</sup>

三是全球产品质量与价值美誉。澳大利亚以其粮食产品干净、安全和品质高闻名，这得益于严格的质保标准和可持续发展实践。在澳大利亚粮食价值链各参与方的协同努力下，通过持续优化管理流程和创新实践，确保了粮食供应链的可持续性。这种管理实现了进口国的法规要求、食品安全标准以及客户的定制化需求和合

同条款。

1.3 澳大利亚粮食产业供应链维护声誉的关键措施

澳大利亚粮食产业的卓越声誉建立在全面的行业规范、质量标准、管理框架及保障流程之上。在该国粮食供应链体系中，由行业主导并积极推动的关键性保障措施详见表 1。

表 1 由行业主导的维护澳大利亚产业供应链声誉的关键措施

Table 1 The industry driven tools to support the reputation of the Australian grain supply chain

关键措施	内容简介
 <p>《澳大利亚的粮食种植》<sup>[3]</sup> <i>Growing Australian Grain</i></p>	作为一本农场作业规范指南，重点围绕风险管理、确保食品安全和优化生产展开，体现了生产领域对采用世界最佳实践以及供应可靠粮食的坚定承诺。
 <p>《澳大利亚粮食产业作业规范》<sup>[4]</sup> <i>Australian Grain Industry Code of Practice</i></p>	粮食产业质量保证计划覆盖了从产前准备、生产过程、收获与储存到交货与营销的完整链条。作为该行业框架的核心，《澳大利亚粮食产业作业规范》系统性地阐述了粮食产业为确保产品符合国内及出口客户需求所采取的具体措施与操作程序。值得注意的是，澳大利亚是全球主要粮食出口国中唯一制定并实施产业作业规范的国家。
 <p>澳大利亚《粮食贸易标准》<sup>[5]</sup> <i>Australian Grain Trading Standards</i></p>	主要用于粮食的质量评估、储存和分类。该标准依据 GTA 的贸易规则及争议解决流程，为商业合同提供支持和指导。GTA 发布的粮食贸易标准涵盖了各类谷物、油籽和豆类商品，详细规定了不同等级的品质和特性，包括蛋白质含量、水分含量和筛分特性等通用指标。这些标准为粮食储存和分类提供了科学依据，确保粮食根据其质量和最终用途适用性进行合理分类和管理。
 <p>《环境、社会 and 治理》 <i>Environmental, social and governance</i></p>	整个供应链对环境、社会 and 治理（Environmental, social and governance, ESG）的关注，体现了消费者对安全、可持续及符合道德标准食品生产的强烈需求。这一趋势为种植者提供了利用其清洁、绿色国家声誉的契机。澳大利亚粮食行业因其在可持续发展方面的表现而备受认可，其在供应链各环节的 ESG 实践值得信赖。GTA 发布了《澳大利亚粮食供应链及其环境、社会 and 治理（ESG）资质》报告 <sup>[6]</sup> ，系统展示了粮食供应链在食品安全、可追溯性、可持续性、人员安全、营养质量及产品完整性等方面的资质，相关内容如图 3 所示。



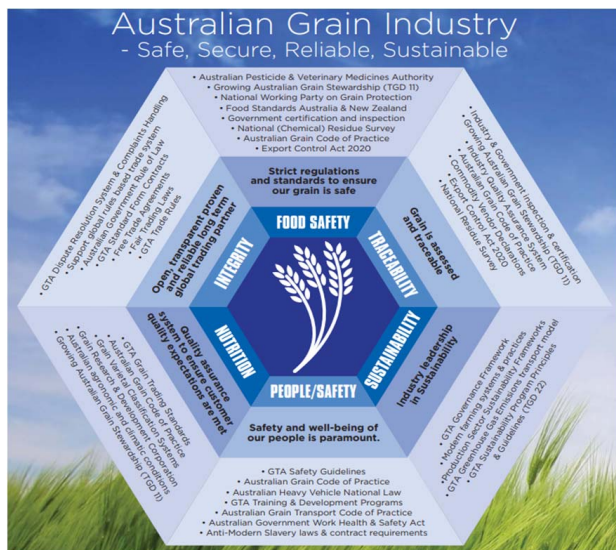


图 3 澳大利亚粮食产业 ESG 框架

Fig.3 Australian grain industry ESG framework

这些由行业主导的举措得到了政府监管的有力支持，并与其形成了协同效应。其中一项重要措施是针对植物检疫要求的政府认证流程——出口粮食必须通过澳大利亚农业、渔业与林业部批准的注册出口机构进行出口。所有粮食出口均需经过政府注册授权官员的严格检查，以确保其符合进口国的检疫标准，包括防止特定病虫害的跨境传播。

## 2 聚焦数字技术在粮食供应链中的作用

### 2.1 技术在粮食供应链中的重要性

新型及改良技术是推动澳大利亚农业实现可持续发展盈利的关键驱动力。这些技术革新不仅能够持续提升粮食产业的经济表现和生产力，还能有效满足食品、饲料和工业消费者的需要，为政府、农民和环境带来积极的成果。

然而，该行业也认识到，粮食价值链的各方参与者有必要加强沟通，以支持因创新而产生的商业产品、工具和/或流程顺利融入价值链，同时确保贸易活动不受干扰。在新技术的商业化推广过程中，粮食价值链在识别和解决新兴的合规监管、市场准入问题以及满足客户需求方面发挥着关键作用。

构建管理指导和认证流程的框架对于确保技术的可靠性至关重要，尤其对于粮食数字视觉评估（评估和量化粮食质量以进行分类和销售）等

技术，这一点十分关键。

数据驱动型农业将为粮食产业带来变革性变化。数字技术正融入整个粮食供应链，以提高可追溯性、生产力、透明度和效率。包括人工智能在内的数字技术有潜力从根本上改变粮食的生产、贸易和消费方式。

### 2.2 数字技术在粮食供应链中的应用

数字技术有望通过提高生产力、改进质量管理流程和可追溯性，以及在整个价值链中建立信任，实现澳大利亚粮食供应链的现代化。主要应用包括：

- (1) 完善系统、流程和能力，以确保食品安全并符合监管要求
- (2) 支持生物安全防范和恢复能力
- (3) 应用工具、知识和技术优化农场运营
- (4) 运用供应链技术改善谷物的物流、储存、运输和营销

数字技术还有望通过提高透明度、确保符合可持续发展标准和市场准入监管要求，建立市场信心，来支持市场准入和 ESG 合规。例如，采用数字化方案可助力粮食产业提高效率/效能（视觉识别技术、区块链等）；满足合规报告或可验证成果/声明（如可持续性、低碳强度等）的市场要求；通过收集和提供汇总的行业层面数据来优化投资。

### 2.3 数字技术在粮食供应链中面临的挑战

尽管数字技术在谷物供应链中展现出诸多潜在优势，但其实际应用过程中仍面临诸多障碍，主要包括以下几个方面：

- (1) 数据治理与信任问题：在供应链管理中，各方对数据所有权和控制权的担忧往往会成为合作的阻碍。特别是在农业领域，当涉及农户数据时，缺乏明确的数据治理框架已成为数字解决方案推广的主要障碍。在供应链体系中，数据共享过程中各方对数据所有权、使用权和控制权的模糊界定，往往会导致利益相关方产生信任危机。农民及数据生态系统的参与者普遍担心，其提供的数据可能在未经充分授权的情况下被不当使用、随意共享或商业变现。因此，建立基于透明

规则、安全技术和公平协议的数据共享机制,对于构建信任关系、消除合作障碍具有关键作用。

(2) 技术碎片化:主要表现为异构数据系统之间的不一致性以及各平台间缺乏有效的互操作性,会导致效率低下。

粮食产业涉及众多利益相关方,各方在数据管理过程中各自采用不同的数据系统和工具。这种异构性可能导致数据集呈现碎片化特征,难以整合。由于平台与技术间的互操作性不足,这将显著制约数据驱动的决策能力和运营优化潜力。因此,构建标准化的数据协议和系统至关重要,同时保持适度的灵活性以实现对新兴技术的无缝集成。

在整个粮食供应链中实施数字技术通常面临重大技术障碍,例如连接问题(澳大利亚许多粮食产区位于农村和偏远地区,难以获得可靠的网络连接),而且新技术的复杂性可能需要专业知识来实施和维护,这对于行业中产业规模较小的农民群体或企业来说是一个障碍。

(3) 商业与物流障碍:在粮食供应链的各个环节中,实际的粮食转换和聚集过程往往导致数据获取和处理的复杂性显著增加。特别是在中小规模的农业生产经营群体中,高昂的数字化转型成本可能成为难以逾越的障碍,限制了先进数字解决方案的广泛应用。

(4) 消费者与利益相关方的信任:即获得种植者和消费者对新技术的信任对于普及采用十分关键。如今的消费者对全球食品和纤维系统提出了越来越高的要求。消费者想知道他们的食物在哪里种植、如何种植、加工、包装和运输。消费者越来越希望在食品安全、健康养生和产品溯源等问题上有更高的透明度。

### 3 应对挑战的策略

澳大利亚粮食产业有信心通过多方面策略来克服这些挑战,包括:

(1) 合作制定政策,为数据治理和互操作性建立明确的规则和框架。

(2) 投资基础设施,扩大互联网连接并对设施进行现代化改造,以支持数字技术。

(3) 开展能力建设,如提供培训项目,提高行业参与者的数字技术素养。

(4) 进行透明沟通,通过展示数字技术的益处和安全性,与消费者和利益相关者建立信任。

通过应对这些挑战,澳大利亚粮食供应链能够充分利用数字化的潜力,提高效率、可持续性和全球竞争力。

有一系列因素推动着应对和改变这些挑战,人们越来越认识到数字农业具有提高生产力和盈利能力以及为农场和供应链带来益处的潜力。同时,技术在迅速进步,能够在不改变操作方式的情况下实现大规模高效数据收集。

与可持续发展和管理相关的发展势头也在推动变革,因为该行业力求更好地展示其 ESG/可持续发展资质,以及满足该领域监管和机构要求的能力。

### 4 增长与现代化机遇

澳大利亚在研发领域的投入已成为推动现代化进程的关键推动力。当前,行业利益相关者正积极运用数字成像、可持续发展等领域的先进技术,对粮食生产进行科学评估。

政府政策与行业举措保持一致至关重要。如 GTA 的《技术路线图》<sup>[7]</sup>和《谷物行业新技术管理框架》<sup>[8]</sup>(图 4)等合作方式,强调了与利益相关者早期接触的必要性,聚焦与合规监管或市场要求相关的市场问题,以及统一贸易工具和质量保证框架的必要性。



图 4 GTA 的《技术路线图》和《粮食产业新技术管理框架》

Fig.4 GTA's Technology Roadmap and Grain Industry Stewardship Framework for New Technologies

这些行业框架不仅为供应链的成功整合提供了途径,而且重要的是帮助了在行业和客户利益

相关者中建立信心。

GTA 抓住技术机遇, 利用数字成像技术补充(消除)了粮食销售评估中的人为主观因素, 这是一个有价值的研究案例样本。这一举措与现代化和提高效率的目标相一致, 但在评估、批准和整合新兴的粮食数字成像评估技术方面存在一些固有挑战。为应对这些挑战, GTA 正在推动制定一项行业标准/程序, 用于统一的技术评估、批准和维护系统。这种方法将有助于创建一个统一的框架, 确保产品和数据的完整性以及质量保证智能性, 这些都是现代化供应链的关键要素。GTA 的流程成果将是一项行业标准和/或程序, 使政府、行业和商业公司能够采用统一系统来评估、批准和维护新兴技术。

## 5 结论与展望

澳大利亚粮食产业处于有利地位, 且其善于利用新兴技术和全球趋势。通过应对挑战、促进创新并优先考虑可持续发展, 该行业能够巩固其“可靠且具有前瞻性的全球供应商”的声誉。依托严格完善的行业标准和始终如一的品质保障, 澳大利亚已成为全球信赖的优质粮食供应基地。

粮食产业将继续拥抱新技术, 但关键在于该行业必须负责任地应用技术, 以赢得并持续维护社会信任, 从而为持续获取创新技术创造良好环境。

随着出口能力的显著提升, 澳大利亚的出口计划呈现持续增长态势, 以充分满足市场需求。数字化转型和创新技术的广泛应用展现出巨大变革潜力, 助力该行业在高效满足市场需求的同时, 严格遵循 ESG 标准, 进一步提升全球竞争力。在行业持续发展的进程中, 行业与政府的紧密协作将发挥关键作用, 成为推动可持续增长和行业现代化的核心动力。通过构建基于行业自主监管的模式, 制定完善行业框架和质量保证实践, 澳大利亚将巩固其作为安全可靠供应来源的地位, 并在满足市场和监管要求方面实现更高效率。

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2. 英文原文详见 P41-46。

RICHARDS R. Opportunities for digitalization and innovation in Australian grain supply chains (英文原文)[J]. Science and Technology of Cereals, Oils and Foods, 2025, 32(3): 34-46.

# Opportunities for Digitalization and Innovation in Australian Grain Supply Chains (英文原文)

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**Abstract:** Australian grain industry is significant to its economic development, characterized by high production capacity, large scale, crop diversification, efficient supply chains and focus on quality and safety, but it is currently under pressure to modernize. The Australian grains industry's positive reputation is due to a range of industry codes, standards and environmental, social and governance (ESG) concerns, with the Grain Trade Association of Australia (GTA) playing a key role. This article provides an overview of the Australian grain industry supply chain, including its characteristics, advantages, and key measures to uphold its reputation. It elaborates on the role of integrating digital and innovative technologies into the supply chain to enhance traceability, covering the importance and applications of such technologies, as well as challenges such as complex data governance, technological fragmentation, commercial and logistical barriers, and public trust issues. The article outlines strategies to address these challenges and analyzes opportunities for supply chain modernization in improving efficiency, ensuring safety, and advancing sustainable development, while offering insights into future prospects. The aim is to provide a reference for ensuring the efficient and sustainable development of the Australian food industry supply chain, and further maintain the global competitiveness of the Australian food industry.

**Key words:** Australian grain industry; supply chain; digital and innovative technologies; measures

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Australia's grain (grain refers to cereals, oilseeds and pulse but excludes rice) industry is a major contributor to the Australian economy, with production of over 50 million tonnes annually and reaching 70.8 million tonnes in 2022/23. With typically over 70% of production exported, the sector is a large earner of export revenue. The

Australian grain industry reached a record annual value of production in 2022/23 forecast (excluding rice) of \$AUD31 billion at the farm gate and \$AUD29.7 billion of exports making it the highest value industry in the Australian agriculture sector, contributing more than 33% of Australia's agricultural gross value of production annually<sup>[1]</sup>.

Australian grain production has demonstrated strong growth over a number of decades and is characterised by a strong production capacity, highly efficient production sector and supply chain, and a strong commitment to safety and quality. However as the global trade landscape evolves, supply chains, including the Australian grain industry, face

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See more details in PC6-12.



increasing pressure to modernise. This modernisation is driven by advancements in technology, the growing importance of sustainability, and the demand for food safety and food security in global markets.

This article provides an overview of how the Australian grain supply chain operates, highlighting the opportunity for digital and innovative technologies and modernisation of supply chain practices to support efficiency, safety and sustainability outcomes. The article delves into how digitalisation and innovation are reshaping the supply chain to ensure efficiency, sustainability, and global competitiveness.

## 1 THE AUSTRALIAN GRAIN INDUSTRY SUPPLY CHAIN: A SNAPSHOT

### 1.1 The Characteristics of Australia's Grain Industry

The Australian grains industry is market oriented

and internationally competitive, with a reputation for safe, quality grain supported by a reliable supply chain with multiple players competing to buy and sell grain for domestic and export markets and encompassing a vast network of on and off-farm storage, rail and road freight paths, and ports.

The Australian grains industry operates in a rapidly changing technical and marketing environment. The industry is globally recognised for its efficiency, with strong safety and quality credentials. It's close proximity to expanding markets, makes the Australian grains industry well placed to realise market growth opportunities over the coming decades.

Australia's grains industry is underpinned by a robust self-regulatory framework. Grain Trade Australia (GTA) plays a pivotal role in maintaining industry standards, facilitating trade, industry stewardship and capability. Refer Figure 1.



Fig.1 Australian grain industry's self-regulatory framework

Australian grain growers are recognised for seeking out and adopting new technology and an appetite for change. Science and technological innovation is progressing at a rapid pace. The global demand for affordable, safe, sustainably produced food, feed and energy underpins the long-term opportunity for the Australian grains industry.

The grain industry, and its ancillary suppliers and service providers, are substantial employers in urban and regional areas from the farm gate through to end point consumption. The growth prospects for the industry are strong, given increased domestic demand and strong economic and demographic growth in the Asia, where wheat imports have doubled since 2000. The industry is well placed to build on its efficient production, reputation for safe and quality food, and proximity to fast growing markets.

### 1.2 The Advantages of Australia's Grain Industry

The Australian grain industry has advantages due to a number of factors including:

(1) Efficiency and scale-grain-Australian growers are innovative, efficient and embrace new practices, tools and technologies which has seen, and continues to see, farming practices evolve and adapt to challenges. Despite farming in one of the world's driest and most variable climates, water-use efficiency and yield of Australia's major crops continues to improve. The Australian grain industry is characterised by increasing production per millimetre of rainfall achieving world leading performance through utilising advanced farming techniques, continually improving genetics and adoption of

technology.

(2) Diverse crop production-Australia produces a range of grain, oilseed and pulse crops (refer Figure 2). Volumes of major crops grown in Australia in 2024/25 were:

- wheat 28.4 million tonnes
- barley 11.6 million tonnes
- canola 6.1 million tonnes
- sorghum 2.1 million tonnes

In 2022-23, grain exports reached nearly 55 million tonnes, contributing over \$32 billion

to the economy.

(3) Global reputation for quality and value-Australia is known for its clean, safe and high-quality grain, supported by strict quality assurance standards and sustainable practices. Australian grain value chain participants work together to continually manage and improve the practices and processes to deliver a sustainable supply of grain to satisfy importing country regulations, food safety and customer and contractual requirements.

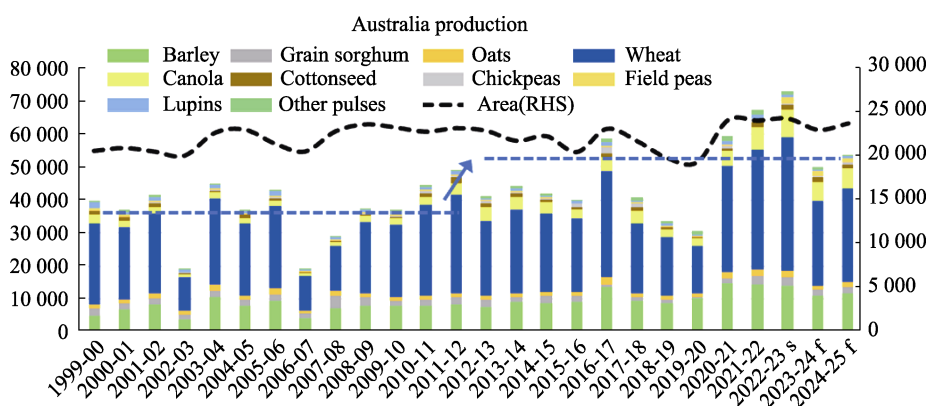


Fig.2 Australian grain production<sup>[2]</sup>

### 1.3 Key Measures to Maintain the Reputation of the Supply Chain of Australia's Grain Industry

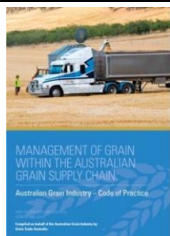
The Australian grain industry reputation is underpinned by a number of codes of practice,

industry standards and frameworks and quality assurance processes. Key Industry driven tools across the Australian grain supply chain that support its reputation refer Table 1.

Table 1 The industry driven tools to support the reputation of the Australian grain supply chain



On farm code of practice-*Growing Australian Grain*<sup>[3]</sup>-which focuses on managing risks, ensuring food safety and optimising production. Growing Australian Grain demonstrates the production sectors' commitment to world's best practice and to supplying reliable grain.



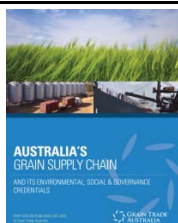
The *Australian Grain Industry Code of Practice*<sup>[4]</sup> - grain industry quality assurance programs cover pre-production, grain production, receival and storage, and outturn and marketing. A key part of the industry framework that overarches and supports these categories is the Australian Grain Industry Code of Practice. It describes the quality assurance practices and procedures that the grain industry uses to ensure Australian grain and grain products meet domestic or export customer requirements. Australia is the only major grain exporting country to have an industry Code of Practice.



Guide to the  
GTA GRAIN TRADING  
STANDARDS  
2024/25 SEASON  
A Project of  
GRAIN TRADE AUSTRALIA  
Twenty-ninth Edition 2024

*Australian Grain Trading Standards*<sup>[5]</sup> for quality assessment, storage and segregation with grain traded under commercial contracts supported by GTA Trade Rules & Dispute Resolution processes. Grain trading standards published by GTA are the foundation for trade used by the Australian industry. Standards for a range of grain commodities are used to segregate grain in storage based on its quality and end-use suitability. GTA Trading Standards describe the qualities and characteristics of the various grades of the grain, oilseeds and pulses and details the common characteristics (such as protein, moisture and screenings).

Continued



Environment, Social and Governance (ESG)—an ESG focus across the supply chain recognises the increasing consumer demand for foods that are safe, sustainable and ethically produced and provides opportunities for growers to leverage Australia's clean green reputation. The Australian grain sector is recognised as an industry that is focussed and has a very positive story on sustainability and strong credentials on ESG aspects across the value chain. GTA has published *Australia's Grain Supply Chain and its Environment, Social and Governance (ESG) Credentials*<sup>[6]</sup> document which seeks to illustrate the grain supply chain credentials with respect to food safety, traceability, sustainability, people and safety, food and nutrition quality and integrity. Refer Figure 3.

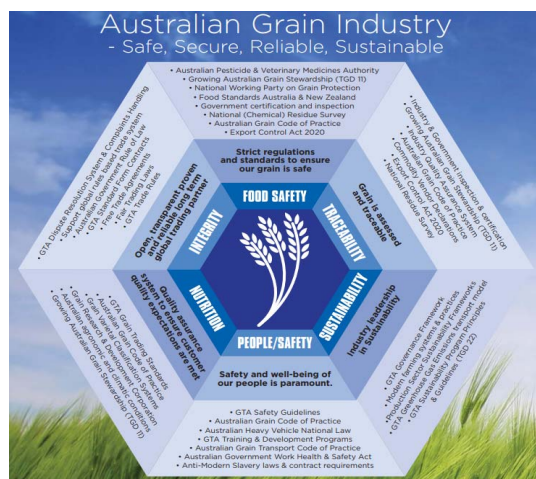


Fig.3 Australian grain industry ESG framework

These industry driven tools are supported by and work with Government inspection including Government certification process for phytosanitary requirements—grain for export can only be shipped from Registered Export Establishments approved by the Australian Department of Agriculture, Fisheries & Forestry. The grain is inspected by government registered Authorised Officers to ensure it meets the quarantine requirements of the importing country which may include freedom from particular pests and diseases.

## 2 ROLE OF TECHNOLOGY IN THE GRAIN SUPPLY CHAIN WITH FOCUS ON DIGITAL TECHNOLOGIES

### 2.1 The Importance of Technology in the Grain Supply Chain

New and improved technologies are a key driver of future sustainability and profitability of Australian agriculture, and important in enabling the grain industry to continually improve economic performance and productivity; meet the demands of food, feed and industrial consumers; and contribute to positive outcomes for governments, farmers, and the environment.

However, the industry also recognises the need for the grain value chain to come together to enable a dialogue that will support commercial

products, tools and/or processes that result from innovation to enter the value chain without disruption to trade. It is important for the grain value chain to identify and address emerging regulatory compliance, market access issues and customer requirements as new technologies seek to be commercialised.

It is also important for some technologies to be supported through frameworks that provide stewardship guidance and certification processes. This is particularly critical for technologies such as digital visual assessment of grain that can be used to assess and quantify grain quality for segregation and sale.

Data-driven agriculture is set to deliver transformational change across the grains industry. Digital technologies are being integrated across the grain supply chain to improve traceability, productivity, transparency, and efficiency. Digital technologies including Artificial intelligence (AI) have the potential to fundamentally transform the way food is produced, traded and consumed.

### 2.2 The Application of Digital Technology in the Grain Supply Chain

These technologies have potential to modernise the Australian grain supply chain through enhancing productivity, improving quality management processes and traceability and fostering trust across the value chain. Key applications include:

- (1) improved systems, processes and capabilities to ensure food safety and compliance with regulatory requirements
- (2) support biosecurity preparedness and resilience
- (3) application of tools, knowledge and technologies to optimise farm performance
- (4) supply chain technologies to improve logistics, storage, transportation and marketing of grains.

They also have potential to support market access and ESG compliance through assisting to provide transparency, compliance with sustainability standards and regulatory requirements for market access, and to build market confidence. For example, adoption of digital solutions could assist the grain industry: improve efficiency /effectiveness e.g. visual

recognition technology, blockchain, etc; meet market requirements around compliance reporting or demonstration of verifiable outcomes/claims (e.g. sustainability, low carbon intensity, etc.); optimise investments through collecting and enabling access to aggregated, industry- level data.

### 2.3 The Challenges Faced by Digital Technology in the Grain Supply Chain

Despite these potential benefits, integrating digital technologies into the grain supply chain is not without challenges. These include:

- Data governance and trust i.e. concerns around data ownership and control may hinder collaboration across the supply chain. A key barrier to adopting digital solutions in the agricultural industry, particularly in relation to farmer data, is the lack of clear data governance frameworks. Uncertainty regarding the ownership, usage rights, and control of data shared across the supply chain can create hesitation among stakeholders. Farmers and other contributors to the data ecosystem are often wary of how their information might be used, shared, or monetised without their consent. Building trust through transparent policies, secure systems, and equitable data-sharing agreements is essential for overcoming this hurdle.
- Technical fragmentation i.e. inconsistent data systems and lack of interoperability across platforms can create inefficiencies. The grain industry involves a wide range of stakeholders each utilising different data systems and tools. This diversity can lead to fragmented datasets that can be difficult to integrate. The lack of interoperability between platforms and technologies may hinder the ability to derive actionable insights and optimise operations. Developing standardised data protocols and systems will critical, while also providing flexibility to enable enhancements and new technologies to be accessed and integrated into supply chains. Implementing digital technologies across the grain supply chain often faces significant technical hurdles, such as connectivity Issues (many grain-producing regions in Australia are in rural and remote areas with limited access to reliable connectivity), and the complexity of new technologies which may

require specialised knowledge for implementation and maintenance can be a barrier for smaller players in the industry.

- Commercial and logistical barriers i.e. the physical transformation and aggregation of grains at various supply chain stages can complicate the ability to capture data-driven insights, and in some cases the cost of implementing advanced digital solutions can be prohibitive for smaller farmers or businesses.
- Consumer and stakeholder trust i.e. gaining grower and consumer trust in new technologies is essential for widespread adoption. Today's consumers are placing increasing demands on the global food and fibre system. Consumers want to know where and how their food is grown, processed, packaged, and transported. There is a growing desire from consumers for transparency around issues such as food safety, health and wellness, and product discovery.

## 3 ADDRESSING THE CHALLENGES

The Australian grain industry is confident that a multi-faceted approach can overcome these challenges. This approach includes:

- (1) Collaborative policy development to establish clear rules and frameworks for data governance and interoperability.
- (2) Infrastructure investment to expand internet connectivity and modernising facilities to support digital technologies.
- (3) Capacity building such as training programs to enhance digital literacy among industry participants.
- (4) Transparent communication to build trust with consumers and stakeholders by demonstrating the benefits and security of digital technologies.

By tackling these challenges, the Australian grain supply chain can fully leverage the potential of digitalisation to enhance efficiency, sustainability, and global competitiveness.

There are a range of factors supporting the momentum to address and change these challenges including the increasing recognition of the role that digital agriculture can play in enhancing productivity and profitability and deliver on-farm and supply chain benefits. There are also rapid advancements occurring in technology to enable efficient data collection at scale with no practice change.



The increasing momentum related to sustainability and stewardship is also driving change as the industry seeks to better demonstrate its ESG/sustainability credentials and the ability to meet regulatory and institutional requirements in this space.

#### 4 OPPORTUNITIES FOR GROWTH AND MODERNISATION

Australia's investment in research and development (R&D) is a critical enabler of modernisation. Industry stakeholders are leveraging advancements in areas such as digital imagery for grain assessment and sustainability.

Alignment between government policies and industry initiatives is crucial. Collaborative approaches, such as GTAs *Technology Roadmap*<sup>[7]</sup> and *Grain Industry Stewardship Framework for New Technologies*<sup>[8]</sup>, emphasise the need for early engagement with stakeholders, focus on market issues related to either regulatory compliance or market requirements, and need for harmonized trading tools and quality assurance frameworks.



Fig. 4 GTA's *Technology Roadmap* and *Grain Industry Stewardship Framework for New Technologies*

These industry frameworks not only provide the pathway for successful supply chain integration but also importantly assist to build confidence with industry and customer stakeholders.

The GTA approach in relation to the opportunity for technology to supplement the subjective human elements in grain assessment for sale with digital imagery is a useful case study example. This move aligns with the broader goals of modernisation and efficiency, but has a number of inherent challenges in assessing, approving and integrating emerging digital imagery grain assessment technologies. To address these challenges, GTA is facilitating the development of an industry standard/ procedure for a uniform system of technology assessment, approval, and maintenance. This approach will support the creation of a harmonised framework that ensures product and data integrity, as well as quality assurance intelligence,

which are key components of a modernized supply chain. The output of the GTA process will be an industry standard and/or procedure to enable Government, industry and commercial companies to adopt a uniform system for assessing, approving, and maintaining emerging technology

#### 5 CONCLUSION: A FORWARD-LOOKING PERSPECTIVE

The Australian grain industry is well- positioned to capitalise on emerging technologies and global trends. By addressing challenges, fostering innovation and prioritising sustainability, the sector can build on its reputation as a reliable and forward focussed global supplier. Australia is a reliable supplier of high-quality grains based on sound industry practices that provide assured quality with confidence.

The grain industry will continue to embrace new technologies, and it is important the industry demonstrates the responsible use of technology in order to capture and maintain community's trust and enables ongoing access to innovative technologies.

Australia's export program continues to grow with increased export capacity to serve its market. Digitalisation and other innovative technologies offer transformative potential, enabling the industry to meet market demands efficiently, comply with ESG standards and enhance its global competitiveness. As the sector continues to evolve, the collaborative efforts of industry and government will be pivotal in driving sustainable growth and modernisation. Building on the industry's self-regulatory approach and developing Industry frameworks and quality assurance practices will ensure that Australia continues to be safe and reliable source of supply and efficiently meets market and regulatory requirements.

#### REFERENCES

See in its Chinese version P34-40.