FINANCIAL IMPLICATIONS OF ADDRESSING WATER-RELATED EXTERNALITIES IN THE PACKAGED MEAT INDUSTRY

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Key findings

- The global consumer staples sector, including the packaged meat industry, faces a $200 billion impact from water scarcity and is the most exposed of all sectors to water risk (Foodnavigator.com 2021). Companies in the consumer staples sector are already suffering financially material impacts caused by their water-related externalities.

- Despite that, in our view current approaches to estimate water risk ignore the value at risk of the widespread negative impacts companies have on water resources, leaving companies and their investors potentially exposed to much higher-than-expected potential losses.

- This brief provides investors with the estimated[1] annual cost to address water-related externalities and reduce value at risk for three representative companies in the packaged meat industry: BRF S.A., Hormel Foods Corporation, and Tyson Foods, Inc,[2] and quantifies the impact of the annual cost on each company's valuation using DWS's[3] Cash Return on Capital Invested (CROCI©) framework[4].

- Eliminating these companies' impacts on freshwater from nutrient runoff and water withdrawals would require an approximate total annual expenditure for BRF S.A., Hormel Foods Corporation, and Tyson Foods, Inc, of US$57.3 million, US$63.2 million, and US$301.4 million respectively.

- The impact of the additional annual expenditure is relatively modest for Hormel and Tyson, but significant for BRF S.A., given its lower profitability and high valuation in 2019. The impact on earnings before interest, taxes, depreciation, and amortization (EBITDA) is modest, ranging from -7.5% to -4.7%, and higher on net profit, ranging from -5% for Hormel Foods Corporation to -165% for BRF S.A.

- Given the limitations and exclusions of the method applied in this brief, the actual annual cost required to address water-related externalities is likely higher than what the results of this brief indicate. However, the cost of inaction could be up to five times higher than the cost of fully addressing the externalities (CDP 2020).

- By spending less than 1/3 of what they annually spend on IT, or even less if solutions are pursued collaboratively with industry peers and suppliers across the value chain, companies in the packaged meat industry could eliminate their contribution to systemic and chronic impacts on water availability and quality and protect the associated value at risks.

- This is a relatively low price to pay considering that companies that take prudent measures will benefit from both greater investor trust and confidence that they are committed to protecting their social and legal license to operate, minimizing raw material price volatility and disruptions, and strengthening their competitive advantage in the face of emerging less water-intensive alternative protein sources.

- This brief highlights that sufficient information is available for companies to estimate the magnitude of water-related externalities across the value chain and inform the potential capital and operational expenditure required to eliminate impacts, reduce value at risk, and capitalize on opportunities in the face of increasing water challenges[5] .

1. All estimates of cost and impact on financial metrics in this paper are based on historical data and are not financial forecasts.
2. Corporates are mentioned for illustrative purposes only. References are not intended to be an investment recommendation
3. Any reference to "DWS" shall, unless otherwise required by the context, be understood as a reference to DWS Group GmbH & Co. KGaA including any of its affiliates or subsidiaries. DWS is a global asset manager headquartered in Frankfurt, Germany.
4. CROCI represents one of many possible ways to analyze and value stocks. Potential investors must form their own view of the CROCI methodology and evaluate whether CROCI and investments associated with CROCI are appropriate for them. See more information in Appendix C or see www.dws.com/capabilities/active-investments/croci/the-croci-way/croci-way/
5. These and other conclusions of this paper are referring to the entire packaged meat industry; the risks described are applicable to all companies within the industry and all analysis resulting in these conclusions has been based on historical data.

1 Valuing water is important for investors

One-third of the water sources on our planet are being over-exploited, and in many regions, accessing additional water supplies is unaffordable, putting global economic and business prosperity at serious risk (Brauman et al 2016). With water shortages ranked among the greatest risks to the global economy, financial institutions and regulators are starting to act. Over 500 investors requested that 1,868 large companies disclose their impacts on freshwater through CDP in 2020 (CDP 2020). In addition, regulators are putting growing pressure on financial organizations to disclose water risks, and 14 financial institutions have joined the Ceres Valuing Water Finance Task Force (Box 1) to strengthen the financial case for corporate water leadership.

However, current approaches to estimate water risk focus mostly on understanding the exposure of different asset classes to physical climate risks (Ceres Investor Water Toolkit), often ignoring the value at risk from the negative impacts corporate externalities have on water resources. The potential for financial impacts associated with corporate externalities on water resources is evident in existing disclosures (Box 2). Unless companies take action to address their externalities on water across the value chain, companies and their investors may be significantly underestimating the widespread physical, regulatory, and reputational water risks across asset classes and investment portfolios, and may be exposed to higher-than-expected potential losses.

Box 1. The Valuing Water Finance Task Force

The global water crisis has created a pressing need to drive capital market actors to play a role in addressing water issues. In response, and as part of the Valuing Water Initiative, the Government of the Netherlands and Ceres partnered to launch the Valuing Water Finance Task Force to help drive corporate action on water-related financial risks. The goal of the Task Force is to raise awareness within the capital markets of the widespread negative impacts of corporate practices on water supplies, as well as to clarify which industries and practices are linked to the most severe and systemic of these impacts. To achieve that, the Valuing Water Finance Task Force has supported the documentation of the scientific evidence on the most severe and systemic private sector water-related externalities to help estimate and inform capital markets on the financial materiality of water-related externalities and guide the development of credible, actionable corporate expectations for valuing water.

Box 2. Financial impacts driven by corporate externalities on water resources

Facing opposition to a $1.5 billion brewery it was building in Mexicali, **Constellation Brands** began dismantling its operations earlier this year. As a result, the company expects a long-lived asset impairment of up to $680 million in the first quarter of fiscal year 2022 (Constellation Brands 2021).

Unilever disclosed to CDP in 2019 that it faces water quality risks linked to the production of consumer products in the Mississippi River Basin. The basin is an area of poor soil and water health but is also where three quarters of soy from the U.S. is sourced. Stretches of the river exceed water quality standards for mercury, bacteria, sediment, PCBs (polychlorinated biphenyl) and nutrients. Soy oil is used in Hellmann's products, one of Unilever's billion-dollar brands. Unilever reports that it is at risk of increasing supplier costs due to higher costs of water and wastewater treatment provision and restrictions in water use. Unilever invests €1-2 million per year in assessing the environmental impacts on farms and ensuring all suppliers comply with their sustainable agriculture code—this includes mandatory requirements on fertilizer use and water quality measurements (CDP 2019).

In March 2018, two pipeline leakages occurred at **Anglo American's** mine in the state of Minas Gerais, Brazil. The incident resulted in a substantive impact of US$600 billion on the group's EBITDA. This includes the cost of 280 days of lost production; immediate risk mitigation including river clean-up and community compensation (approximately US$7.5 million); the inspection and repair of the pipeline (US$20 million); and eight non-compliance notices (US$50 million). Remedial action included provision of potable water to the community; immediate clearing of iron ore sediment on affected land and in the river; and recovery and restoration of areas within eight miles beyond the affected area (CDP 2019).

To help address this gap[6], Ceres, with insights from the Valuing Water Finance Task Force and Investor Working Group, collaborated with water risk consultant Bluerisk sustainability intelligence provider, S&P Global Sustainable1, and the asset manager DWS Group to estimate the financial materiality of addressing water externalities for three companies in the packaged meat industry. This work was designed to provide an analytical evidence-base to support investor engagement of packaged meat companies that, this document aims to inform investors interested in:

- Understanding the financial materiality of addressing water-related externalities in the packaged meat industry.
- Applying the proposed methods to other portfolio companies in the packaged meat or other industries.
- Using the results to inform their engagements with companies on water.[7]

2 Relevance of water-related externalities in the packaged meat industry

Barclays Capital in June 2021 estimated that the global consumer staples sector, including the packaged meat industry, faces a US$200 billion impact from water scarcity and is the most exposed of all sectors to water risk (Foodnavigator.com 2021). Furthermore, The University of Saskatchewan Global Institute for Water Security Global Impact Assessment (Global Institute for Water Security 2021) and subject matter experts identified several water-related practices and externalities associated with the packaged meat industry that are responsible for systemic and chronic impacts on the health of freshwater resources. To better understand where and why these occur, we linked each externality to specific activities and mapped them across the value chain of the packaged meat industry (Table 1).

Table 1. Externalities associated with the packaged meat industry identified from scientific literature and subject matter experts.

Value chain section	Activity	Externality	Freshwater Impact	Business Risk Examples
Grain for feed production	Fertilizer applications	Nutrient loading	Eutrophication	Increased cost of grain/feed Increased CAPEX/ OPEX to access alternative water supply Litigation over impacts on downstream water quality or groundwater depletion Loss of social and legal license to operate
	Irrigation	Water withdrawals	Water stress	
	Pesticide and herbicide applications	Pesticide and herbicide in runoff	Toxicity for aquatic life	
	Land conversion and deforestation	Sedimentation and salinity	Suspended solids, toxicity for aquatic life	
Animal raising	Manure	Nutrient loading	Eutrophication	
	Livestock drinking and service water	Water withdrawals	Water stress	
	Manure disposal	Pharmaceuticals; and Lagoon leakage and overflow	Inhibition of microbial and bacterial growth, bioaccumulation in aquatic life, eutrophication	
	Livestock grazing	Overgrazing	Suspended solids	
Animal processing and packaging	Processing water discharge	Wastewater discharge	Eutrophication, toxicity for aquatic life, inhibition of microbial and bacterial growth, bioaccumulation in aquatic life	
	Processing water use	Water withdrawals	Water stress	
Distribution	Retail water use	Water withdrawals	Water stress	
Consumer use	Product packaging	Use and discard of plastic packaging	Impact on aquatic life	

6. Corporates are mentioned for illustrative purposes only. References are not intended to be an investment recommendation.
7. For this report, materiality refers to what is important enough to be included in and what can be omitted from a financial statement. Externalities refer to the environmental and societal costs caused by a company that are not financially incurred or covered by the company.

3 Annual cost required to address water-related externalities in the packaged meat industry

DWS's Cash Return on Capital Invested (CROCI©) framework currently provides coverage for three packaged meat companies: BRF S.A. (BRF), Hormel Foods Corporation (Hormel), and Tyson Foods, Inc. (Tyson). Because of that, these three companies were selected to estimate the impact that the annual cost to address water-related externalities may have on the valuation of each company using the CROCI© methodology, and the degree to which water-related externalities may be financially material to other packaged meat companies. BRF, Hormel, and Tyson are three of the world's largest packaged meat companies and represent sales of US$ 60 billion in 2019 and market capitalization of US$ 55 billion (Table 2).

Of the externalities identified in Table 1, we used publicly available data in scientific literature to estimate the magnitude of the externalities from nutrient loading, water withdrawals, and wastewater discharge, and attributed to each company the fraction of the externality they are responsible for, using BRF, Hormel, and Tyson disclosures, geospatial analysis, and S&P Global Trucost, [data as of July 25, 2021] revenue data.

Limitations in data available required that certain externalities be excluded from the scope of this research (Appendix A), including pesticide and herbicide runoff, sedimentation and salinity, pharmaceutical discharge, lagoon leakage and overflows, overgrazing, water withdrawals from distribution and use, and discarding of plastic packaging.

Table 2. About BRF, Hormel, and Tyson. Source: Company Data as of 2019.

Company	Revenue (US$ B)	Net Attributable Profit (US$ B)	Location	Employees
BRF	8.478	0.041	Headquartered in Brazil, present in 117 countries	>100,000
Hormel	9.497	0.979	Headquartered in U.S., distributes to over 80 countries	>20,000
Tyson	42.405	2.022	Headquartered in U.S., operations in 10 countries, serving 5 continents	141,000

Box 3. Existing company commitments to address water-related externalities

Because BRF, Hormel, and Tyson have publicly committed to treat all wastewater discharges, we assumed no additional cost will be required beyond what has already been forecasted. Similarly, because BRF has a commitment to reduce water consumption by 13% by 2025, we adjusted the externalities associated with BRF's processing water proportionally to its commitment. Companies without voluntary commitments or legal requirements to treat all wastewater discharge or reduce water withdrawals may face significantly higher costs of action than the companies analyzed in this brief.

After estimating the magnitude of the externalities, we developed and applied methods (Appendix B) to estimate the annual cost required for each company to eliminate its externalities. The results (Table 3) consider existing company commitments (Box 3) and indicate that eliminating that eliminating BRF, Hormel, and Tyson's impacts on freshwater from nutrient runoff and water withdrawals would require an approximate total annual expenditure, including CAPEX and OPEX, of US$57.3, US$63.2, and US$301.4 million respectively. For Tyson and Hormel, the annual cost is roughly equally divided between addressing water withdrawals and nutrient runoff externalities. For BRF, 98% of the annual cost is for addressing nutrient runoff externalities rather than water withdrawals, given BRF's relatively low impacts on water availability because there are low levels of water stress across much of Brazil.

Table 3. Estimated annual cost required to address water externalities across the value chain for three packaged meat companies.

			Annual cost to address externalities					
			Tyson		Hormel		BRF	
Value chain section	Externality	Sample solutions (WRI 2020)	US$/year	Percentage of total annual cost to address externalities	US$/year	Percentage of total annual cost to address externalities	US$/year	Percentage of total annual cost to address externalities
Grain for feed production	Nutrient runoff from fertilizer	Riparian buffers, wetland restoration, nutrient management	29,777,000	10%	6,669,000	11%	9,946,000	17%
	Withdrawals for irrigation of grain for feed	Irrigation scheduling, drainage construction, advanced sprinkler systems	84,958,000	28%	15,670,000	25%	418,000	1%
Animal raising	Nutrient runoff from manure	Animal waste management systems, grazing and pasture management	95,836,000	32%	21,464,000	34%	46,532,000	81%
	Livestock drinking and service water withdrawals	Efficient washing equipment, leakage reduction activities, water reuse and recycling	82,319,000	27%	18,437,000	29%	368,000	1%
Animal processing and packaging	Wastewater discharge	Secondary and tertiary wastewater treatment	Addressed by existing company commitments					
	Meat processing and packaging water withdrawals	Industrial water efficiency measures, water pressure reduction, water reuse and recycling	8,514,000	3%	943,000	1%	n/a	n/a
Total annual cost to address externalities			301,404,000	100%	63,183,000	100%	57,264,000	100%

These results provide high-level and conservative estimates of the annual expenditure required by BRF, Hormel, and Tyson to address the externalities and associated freshwater impacts considered in this research. The actual annual cost is likely higher than what the results of this brief indicate due to the exclusion of the externalities listed in Appendix A. Furthermore, there are several assumptions and limitations that must be considered. First, estimates for total sourced grain, number of animals, and packaged meat were obtained from Tyson disclosures on total meat production and corn requirements per animal, and BRF disclosures on number of animals. Due to limited disclosures from Hormel, we developed a factor based on revenue calculated from Tyson disclosures and S&P Global Trucost, [data as of July 25, 2021] revenue data and applied it to estimate total bushels of corn and meat production for Hormel. Given that the relative breakdown in beef, pork, and chicken production, corn requirements, and meat production per animal are not the same for Hormel and Tyson, the factors could be improved in the future through enhanced disclosures or direct engagement with the company. Other assumptions include the use of corn as a proxy for all feed grain and limiting grain sourcing to Brazil for BRF and to the U.S. for Tyson and Hormel.

4 Water-related financial materiality of addressing water externalities for three packaged meat companies

After estimating the annual cost to address externalities, we conducted a sensitivity analysis to evaluate the potential impact of the additional annual expenditure on each company's valuation based on their 2019 financial performance, using DWS's CROCI© methodology. CROCI is a cash-flow-based analysis which makes companies' accounting data comparable through economic adjustments by accounting for hidden liabilities, and unreported assets, depreciating assets in a similar manner and accounting for assets' replacement value (Appendix C). Economic P/E is the CROCI version of the Price to Earnings ratio.

The results (Table 4) indicate that the impact of the additional annual expenditure, as calculated in this brief, is relatively modest for Hormel and Tyson, but significant for BRF, given its lower profitability and high valuation in 2019. Specifically, the results highlight:

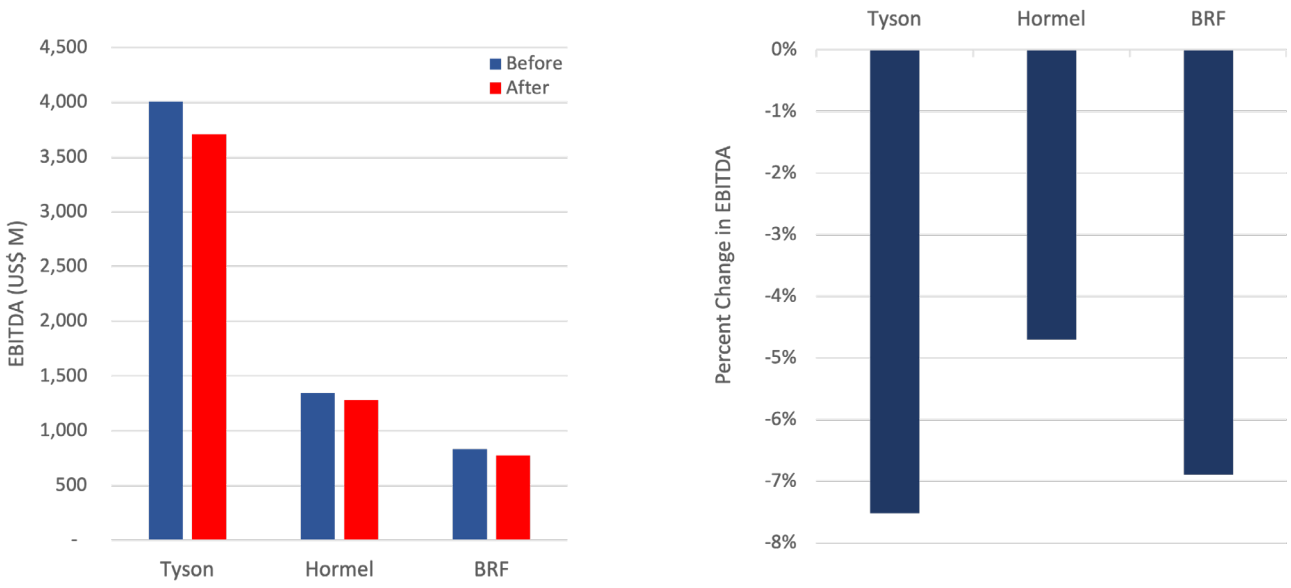
- Modest impact on EBITDA ranging from -7.5% to -4.7% (Figure 1).
- Modest impact, in terms of percentage, on CROCI, ranging from -1.1 to -0.6 percentage points.
- Higher impact on net profit, ranging from -5% for Hormel to -165% for BRF, given its higher financial gearing (BRF's net debt was around 2.5x its net asset value with 69% of market cap in 2019).

Table 4. Impact of the annual cost to address externalities on the valuation of BRF, Hormel, and Tyson using DWS's CROCI© Framework (financial year 2019).[8]

Before incorporating the annual cost to address externalities (US$ M)	Economic P/E	Accounting P/E	CROCI cash return[8]	CROCI Cash Flows	Adj. EBITDA	Adj. Net Profit
Tyson	20.2x	12.3x	12.7%	4,059	4,008	2,099
Hormel	33.0x	24.7x	17.1%	1,340	1,345	930
BRF	60.7x	225.5x	2.5%	821	831	28
After incorporating the annual cost to address externalities (US$ M)	**Economic P/E**	**Accounting P/E**	**CROCI cash return**	**CROCI Cash Flows**	**EBITDA**	**Net Profit**
Tyson	22.2x	13.9x	11.5%	3,826	3,707	1,866
Hormel	34.7x	26.1x	16.3%	1,291	1,282	881
BRF	81.6x	NM	1.9%	775	774	- 19
Impact of the annual cost to address externalities	**Economic P/E**	**Accounting P/E**	**CROCI cash return (bp)**	**CROCI Cash Flows**	**EBITDA**	**Net Profit**
Tyson	2.0x	1.5x	-1.1%	-5.7%	-7.5%	-11.1%
Hormel	1.8x	1.4x	-0.9%	-3.6%	-4.7%	-5.2%
BRF	20.9x	NM	-0.6%	-5.7%	-6.9%	-165.4%

8. CROCI cash return is the equivalent of profitability (return on equity) in the CROCI© framework.

Figure 1. Impact of the annual cost to address externalities on EBITDA in US$M and as a percent change, based on the 2019 annual currency conversion rate.



It is important to note that the annual cost to address externalities accounts only for the cost of eliminating water externalities associated with each company's activities. It does not consider the cost of mitigating or adapting to water-related risks driven by externalities caused by other water users or physical climate risks, and the impact of market conditions (Box 4).

For example, the price of grain, a key input cost of the packaged meat industry, accounts for around a third of the cost of production of a fully vertically integrated company like BRF. Water-related impacts on grain production caused by increasing water stress (Figure 2) or droughts could have considerable impact on supply availability and on the price of grain, and could heavily impact companies' margins and consumer prices. A rise in grain price of 10% could impact EBITDA for packaged meat producers by up to 15% for more profitable companies, and up to 30% for less profitable companies. Impacts like these may be mitigated by hedging in the short to medium term. For instance, during the 2011-2012 period corn price (CBT US$/bu) increased by 54% compared to the previous year, and soybean (CBT US$/bu) by 25%. This led to a negative impact on EBITDA margins for BRF, Hormel, and Tyson, and a drop in CROCI cash return of 290bp for Tyson. Keeping this in mind, companies and investors should not underestimate the potential impacts the price in feed volatility may have on a company valuation, considering that at the time this brief was written the price of corn (CBT US$/bu) has more than doubled from trough to peak over the last 18 months and is up more than 60% on average through the year to date compared to 2020. The price of soybeans (CBT US$/bu) has doubled from trough to peak over the last 18 months and is up more than 46% on average through the year to date compared to 2020.

The results also exclude the cost of restoring impacts from past externalities and the cost savings and increased revenue generation potential associated with implementing solutions. Because of this, additional data and analysis is required to understand the full costs and benefits and associated impacts on BRF's, Hormel's, and Tyson's EBITDA and net profits.

Box 4. Financial impacts driven by externalities caused by other water users or physical climate risks, and their impact on market conditions

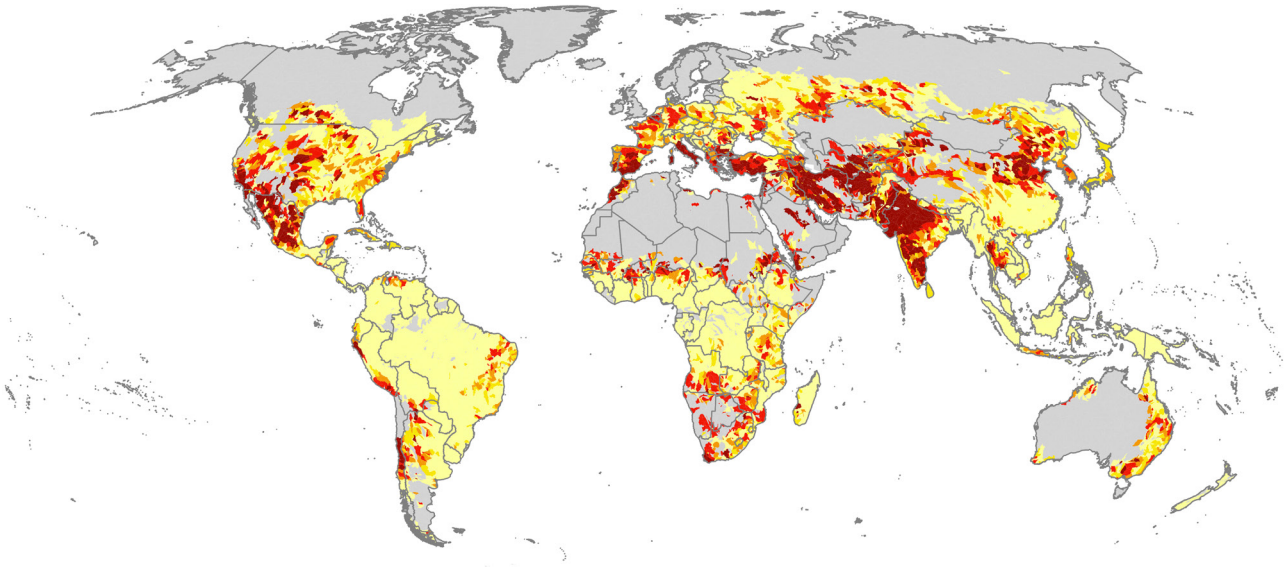
Australian Agricultural Company (AACo) estimated a loss of AUS$ 107 million in EBITDA in FY19 due to extreme weather events including the Gulf floods, which impacted 800,000 hectares of their property (Food Dive, 2019).

Flooding across the Mississippi River Basin impacted millions of acres of corn and soybeans, which increased futures prices and resulted in shares of **Tyson** falling 4.8% and shares of **Sanderson Farms Inc.** and **Pilgrim's Pride Corp.** falling more than 11% from mid-May to mid-June in 2019 (Wall Street Journal, 2019).

Tyson predicts operating margins for its beef business to decline next year amid herd liquidation due to pasture and hay crop impacts from the drought spanning much of western North America (Reuters, 2021).

Flood damage led to an estimated $400 million in losses for Nebraska's cow-calf industry and another $440 million in crop losses in 2019. The flood damage also caused disruptions in the supply chain of **Hormel** (Reuters 2019).

Figure 2. Map of baseline water stress in areas of corn production (WRI 2019, EarthStat).



5 Implications[10] for companies and investors

Given the limitations and exclusions referenced above, the actual annual cost required to address water-related externalities is likely higher than what the results of this brief indicate. The annual cost of mitigating or adapting to emerging water-related risks must be added to that, highlighting that companies in the packaged meat industry and their investors must not underestimate future expenditures required to minimize value at risk. However, while the annual cost to address water-related externalities may be daunting, the cost of inaction can be up to five times higher (CDP 2020).

Large companies (with over US$2 billion in revenue) typically spend around 3.2% of their revenue on IT (Techvera 2021). The results of this brief indicate that large companies in the packaged meat industry would need to spend less than 1/3 of what they spend on IT to eliminate their contribution to systemic and chronic impacts on water availability and quality and help mitigate the associated risks. The annual cost required to address these impacts could be significantly lowered if solutions are pursued collaboratively between companies, across the value chain, and across the industry.

This is a relatively low price tag for companies in the packaged meat industry to address their impacts on water resources, considering that the companies that do are likely to benefit from greater investor trust and confidence that the company is committed to protecting its social and legal license to operate, minimizing price volatility and disruptions in raw material sourcing, and strengthening its competitive advantage in the face of emerging less water-intensive alternative protein sources.

The information and methods provided in this brief, as well as recent commitments by companies such as Cargill (Cargill 2021), are indicative that sufficient information is available to estimate the magnitude of water-related externalities across the value chain, particularly when the work is carried out by the company in question and detailed operational and procurement data are accessible.

The reliance on grain in the packaged meat industry is of particular importance, given that more than 90% of water consumption in water-scarce regions takes place on irrigated farms and 20% of that irrigation is supplied with non-renewable groundwater (Wada et al 2012). Investors should pay special attention to corporate disclosures to ensure that actions are prioritized in the highest impact sections of the value chain and in response to the contextual challenges each company faces at the locations where it operates and sources from (Figure 2).

Companies and investors in other sectors are encouraged to use these methods to estimate their impacts on water resources across the value chain and the cost of taking action to ultimately inform the potential capital and operational expenditure required to eliminate impacts, reduce value at risk, and capitalize on opportunities in the face of increasing water challenges.

What should investors consider when engaging companies?

Based on the results of this brief, investors engaging companies should consider the following:

- Has the company assessed the value at risk from water-related externalities?
- To minimize the value at risk from water-related externalities:
  - Has the company assessed the cost and financial implications of addressing water-related externalities?
  - How is the company planning to re-allocate expenditures to cover the additional cost?
- Is the company investing the data collection infrastructure required to make these decisions?

9. These and other conclusions of this paper are referring to the entire packaged meat industry; the risks described are applicable to all companies within the industry and all analysis resulting in these conclusions has been based on historical data.

Appendices

Appendix A: Externalities excluded from this research

- **Pesticide and herbicide runoff**
  There are numerous compounds applied to agriculture, the regulatory requirements vary across regions, and pesticide exceedance studies are limited and context-specific, making it difficult to quantify and extrapolate the origins and exceedances of company pesticide and herbicide applications (Stackpoole et al. 2021). Additional geographic data is required on pesticide consumption trends and regulations.
- **Sedimentation and salinity**
  Though the impacts on soil erosion and soil health are significant, the level of annual land conversion and deforestation attributed to each company is difficult to quantify due to the chronic nature of the issue, unknown geographies of value chains, and whether companies source from existing or recently developed farms.
- **Pharmaceuticals**
  Though antibiotics can impair aquatic life, there is a lack of information on current antibiotic use in the livestock industry, particularly in the US after recent updates in regulations. Additional data and research are required on antibiotic use and the proportion of applications that enter water bodies.
- **Lagoon leakage and/or overflow**
  Spillage from lagoons can impact water quality; however, the approximate number of lagoons within each company's value chain is unavailable, along with how the lagoons are managed in the face of regulations and extreme events such as flooding.
- **Overgrazing**
  Sedimentation in water bodies can be the result of numerous activities and events in addition to overgrazing, and the impacts are context-specific and vary across regions and ecosystems. Additional data is required on pasture management practices and proximity to water bodies with excess sediment loads.
- **Water withdrawals from distribution**
  The impacts are negligible relative to other impacts across the value chain and therefore excluded from this research.
- **Use and discard of plastic packaging**
  There are high levels of uncertainty and very limited data to attribute consumer behavior related to use and discard of plastic packaging to specific companies.

Appendix B: Methods to estimate the annual cost of addressing water-related externalities

B1. Nutrient loading (from fertilizer applications)

Method: $C_1 = (C_N * 50\% * L_{Nf}) + (C_P * 50\% * L_{Pf})$
In which,
C_1 = Total cost of reducing nutrient runoff from fertilizer by 50% ($/year)
C_N = Cost of reducing a kilogram of nitrogen ($/kg)
L_{Nf} = Nitrogen load from fertilizer attributed to each company (kg / year)
C_P = Cost of reducing a kilogram of phosphorus ($/kg)
L_{Pf} = Phosphorus load from fertilizer attributed to each company (kg / year)

Total nitrogen and phosphorus load from fertilizer per company are determined from estimates of fertilizer inputs into water bodies from the SPARROW model for the Midwest region of the United States (USGS 2020). The nutrient loads are broken down by each company's total number of animals and estimated bushels of corn to feed each animal type (Tyson 2019, BRF 2020) as a percentage of total corn production in the United States (USDA 2021), and the percentage of fertilizer in the United States used on corn (USDA 2019). The nutrient load reduction target is set at an arbitrary threshold of 50% for both nitrogen and phosphorus due to the variability and context-specific nature of nutrient excess in water bodies (WRI 2020). Solution costs are determined from average costs to reduce nitrogen and phosphorus loading into water bodies (WRI 2020).

Assumptions
- Corn for grain is used as a proxy for feed.
- Nutrient loads from the Midwest region of the United States are assumed to be representative of nutrient loads from corn production in the country due to the high concentration of corn production in the region.

- Nutrient runoff from manure is excluded to avoid double counting (see the value chain section on Animal Raising).
- The percent breakdown in shares of beef, pork, and chicken for Hormel is assumed to follow the same breakdown as Tyson Foods, and a factor based on revenue (S&P Global Trucost, [Data as of July 25, 2021]) is applied to estimate total bushels of corn for Hormel.
- The calculations are based on datasets specific to the United States. Though BRF S.A. is located in Brazil, the assessment is a proxy that is intended to quantify the magnitude of the externality.
- Average costs for the agricultural sector are used to remove a pound of nitrogen or phosphorus from entering a water body.

B2. Water withdrawals (from irrigation)

Method: $C_2 = C_{Wag} * P_{bws\ maize} * W_{irr}$

In which,

C_2 = Total cost of reducing water withdrawals from irrigation to eliminate water stress ($/year)

C_{Wag} = Cost of reducing water withdrawals in the agricultural sector ($/m^3)

$P_{bws\ maize}$ = Percent withdrawal reduction required to eliminate water stress in maize production areas (%)

W_{irr} = Water use from irrigated feed for each company (m^3/year)

Water withdrawals from irrigation for each company are determined from the total number of animals and estimated bushels of corn to feed each animal type (See B1) and irrigated water applications for a bushel of corn (Brauman et al. 2020, Field to Market 2016). The water withdrawal reduction target is calculated based on the percentage of maize production (EarthStat) in water stressed areas (WRI 2019), and the reduction in withdrawals required to eliminate the stress. Solution costs are determined from integrated solution cost curves for the agricultural sector to reduce a cubic meter of water (WRI 2020).

Assumptions

- Corn for grain is used as a proxy for feed.
- The percent breakdown in shares of beef, pork, and chicken for Hormel are assumed to follow the same breakdown as Tyson Foods, and a factor based on revenue (S&P Global Trucost, [Data as of July 25, 2021]) is applied to estimate total bushels of corn for Hormel.
- The calculations are based on datasets specific to the United States. Though BRF S.A. is located in Brazil, the assessment is a proxy that is intended to quantify the magnitude of the externality.

B3. Nutrient loading (from Manure)

Method: $C_3 = (C_N * 50\% * L_{Nm}) + (C_P * 50\% * L_{Pm})$

In which,

C_3 = Total cost of reducing nutrient runoff from manure by 50% ($/year)

C_N = Cost of reducing a kilogram of nitrogen ($/kg)

L_{Nm} = Nitrogen load from manure attributed to each company (kg / year)

C_P = Cost of reducing a kilogram of phosphorus ($/kg)

L_{Pm} = Phosphorus load from manure attributed to each company (kg / year)

Total nitrogen and phosphorus loads from manure per company are determined from estimates of manure nutrient inputs into water bodies from the USGS SPARROW model for the Midwest region of the United States (USGS 2020). The nutrient loads are broken down by each company's total number of animals and estimated meat production as a percentage of total meat production in the United States (Tyson 2019, BRF 2020). The nutrient load reduction target is set at an arbitrary threshold of 50% for both nitrogen and phosphorus. Solution costs are determined from average costs to reduce nitrogen and phosphorus loading into water bodies (WRI 2020).

Assumptions

- Corn for grain is used as a proxy for feed.
- Nutrient loads from the Midwest region of the United States are assumed to be representative of nutrient loads from manure in the country due to the high concentration of livestock in the region.
- Nutrient runoff from manure is assumed to originate from livestock raised for meat production.
- The percent breakdown in shares of beef, pork, and chicken for Hormel are assumed to follow the same breakdown as Tyson Foods, and a factor based on revenue is applied to estimate total meat production for Hormel.
- The calculations are based on datasets specific to the United States. Though BRF S.A. is located in Brazil, the assessment is a proxy that is intended to quantify the magnitude of the externality.
- Average costs for the agricultural sector are used to remove a pound of nitrogen or phosphorus from entering a water body.

B4. Water withdrawals (from livestock drinking and service water)

Method: $C_4 = C_{Wind} * P_{bws\ pasture} * W_{livestock}$

In which,

C_4 = Total cost of reducing water withdrawals from livestock drinking and service water to eliminate water stress ($/year)

C_{Wind} = Cost of reducing water withdrawals in the industrial sector ($/m³)

$P_{bws\ pasture}$ = Percent withdrawal reduction required to eliminate water stress in pasturelands (%)

$W_{livestock}$ = Water use from livestock drinking and service water for each company (m³/year)

Water withdrawals from drinking and service water for each company are determined from each company's total number of animals (See B1) and estimated water withdrawals per animal type used for livestock drinking water and service water (USGS 2009). The water withdrawal reduction target is calculated based on the percentage of pasturelands (EarthStat) in water stressed areas (WRI 2019), and the reduction in withdrawals required to eliminate the stress. Solution costs are determined from integrated solution cost curves for the industrial sector to reduce a cubic meter of (WRI 2020).

Assumptions

- Water withdrawals for livestock include uses for drinking water and non-drinking water (i.e., cleaning, sanitation, refreshing of barns, etc.)
- The percent breakdown in shares of beef, pork, and chicken for Hormel are assumed to follow the same breakdown as Tyson Foods, and a factor based on revenue (S&P Global Trucost, [Data as of July 25, 2021]) is applied to estimate the total number of animals for Hormel.
- The calculations are based on datasets specific to the United States. Though BRF S.A. is located in Brazil, the assessment is a proxy that is intended to quantify the magnitude of the externality.
- Solution costs for water use in the industrial sector are assumed to be applicable to servicing livestock; for example, water efficiency, reuse, and recycling measures.

B5. Wastewater discharge (from processing water discharge)

The cost of wastewater discharge is assumed to already be incorporated by the companies due to their public disclosures on wastewater treatment.

B6. Water withdrawals (from processing water)

Method: $C_6 = C_{Wind} * P_{bws\ assets} * W_{processing}$

In which,

C_4 = Total cost of reducing water withdrawals from meat processing and packaging to eliminate water stress ($/year)

C_{Wind} = Cost of reducing water withdrawals in the industrial sector ($/m³)

$P_{bws\ assets}$ = Percent withdrawal reduction required to eliminate water stress for assets in water stressed areas (%)

$W_{processing}$ = Water use from meat processing and packaging for each company (m³/year)

Water withdrawals for meat processing and packaging for each company are determined from disclosed direct operational withdrawals (S&P Global Trucost, [Data as of July 25, 2021]). The water withdrawal reduction target is calculated based on the percentage of company assets (S&P Global Trucost, [Data as of May 28, 2021]) in water stressed areas (WRI 2019, CDP 2020), and the reduction in withdrawals required to eliminate the stress. Solution costs are determined from integrated solution cost curves for the industrial sector to reduce a cubic meter of water (WRI 2020).

Assumptions

To estimate the percentage of company assets in water stressed areas, there is no revenue data per asset to weight the estimate, and so an average is calculated from all assets used in the analysis.

Appendix C: CROCI methodology

CROCI© ("Cash Return on Capital Invested") is a proprietary company analysis and valuation platform of DWS Investments UK Limited and/or its affiliates ("DWS"). Founded in 1996, CROCI© seeks to achieve a full understanding of companies' economic assets, value chain and cash profitability – the goal is to put companies across countries and different sectors on a level playing field where their fundamental data can be directly compared without the imbalances that different accounting standards or business models might introduce. The heart of CROCI© is a dedicated company analyst research team of approx. 50 members covering over 800 large cap companies around the world. Originating in research, CROCI© analysis continues to be used for bottom-up analysis of equity markets but has also been employed in dedicated investment products since 2004: these are primarily systematic, rules-based strategies seeking exposure to concentrated value (i.e., systematically investing in companies with attractive economic valuation based on CROCI© analysis). The CROCI© analysis model is standardized in the sense that there are clear guidelines for how to reconstruct corporate balance sheets including off-balance sheet liabilities; how to measure the key economic assets of a company and their useful life; and how

to measure the cash profitability of a company. However, the analysis model is flexible enough to provide the option of sensitivity analysis based on different hypothetical assumptions or parameters – and this is how CROCI© has contributed to this study: by modelling how the cash profitability, valuation and other fundamentals of specific companies would change under different assumptions regarding the increased expense to companies when bearing the cost of their water externalities in part or full.

Although information for CROCI© metrics has been obtained from sources believed to be reliable, we do not guarantee its accuracy, completeness or fairness, and it should not be relied upon as such. All CROCI© metrics reflect our judgment on a certain date and are subject to change without notice and involve a number of assumptions which may not prove valid.

DWS is not responsible for, and expresses no opinion in relation to, any of the analysis or numerical data which are not a direct result from the use of the CROCI© methodology, including, but not limited to, those included in Parts 1-3.

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