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Mountain States Oilseeds:
Risk Management for Safflower Production in the Intermountain West

Agribusiness Master's Thesis

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Abstract

Safflower is an oilseed crop primarily produced in the western Great Plains because of its compatibility with cereal grain equipment. Varieties grown in that region are harvested predominantly for seeds high in safflower oil and oleic acid that are processed and used in cooking oil, human nutrition, and other health and beauty products (Bergman and Kandel 2019). Safflower is also grown in Utah, Idaho, and California for birdseed mixes due to the region's arid climate, which yields a crisp, white seed that is highly favorable in the birdseed market (Godfrey 2022). Mountain States Oilseeds, headquartered in American Falls, Idaho, is one of the United States' largest processors of safflower seed and is the nation's No. 1 supplier of safflower seed used in birdseed mixes (Mountain States Oilseeds n.d.). While increasing demand for oilseeds will bolster Mountain States Oilseeds' business, producers often view safflower as a minor annual crop with a high-risk profile and minimal expected returns. Thus, MSO must develop a strategy to entice more dedicated oilseed production as resource constraints tighten across the Western U.S. and the worldwide demand for safflower oil, birdseed, and meal continues to expand.

Key Words: Agribusiness, contracting, oilseed, risk management, safflower

JEL Code: Q13, M10, C6

1 Introduction

Jason Godfrey, the owner and president of Mountain States Oilseeds(MSO), sits at his desk at the company's headquarters in American Falls, Idaho, following a meeting with his fellow leadership team. Oilseed processing has been a mélange lately. Consumer demand for processed safflower seed products is currently high, but securing a steady supply of quality safflower seed has been difficult.

War between Russia and Ukraine has heavily disrupted the supply chain by reducing the amount of raw safflower seed available on global markets (USDA 2022a). Ukraine and Russia account for approximately 89,287 tons of safflower seed (Selina Wamucii 2022a; Selina Wamucii 2022b). The war has also led to American farmers experiencing increased costs for fertilizer manufactured in Eastern Europe. Hot weather and several years of drought grip the western U.S., and growers have been forced to rethink crop rotations and focus on allocating water to high-value crops. These events have pushed raw safflower seed prices to an unprecedented 0.30 $/lb in the United States (Godfrey 2022).

Early in its adoption stage, safflower was only produced by contracting with a processing plant. As a niche specialty crop, finding buyers on the open market was nearly impossible, and demand for safflower was driven primarily by oilseed processors. Since then, adoption has grown, and just over 14.8 million lbs. of raw safflower seed were produced in Idaho in 2021 (USDA 2022b). Mountain States Oilseeds contracts for most of the source that moves through its processing facility. Jason is concerned that as the market has grown, opportunities for speculation on the spot market have incentivized risk-tolerant growers to move away from contracts to try and capitalize on slightly higher prices.

Many farmers are skeptical of the economic feasibility of replacing traditional, familiar enterprises with safflower, which has had historically thin margins when other small grains have performed well. Traditional crop rotations within the region have consisted of corn or alfalfa with wheat, barley, or triticale interspersed on years of soil regeneration. Jason is under pressure to meet contracts that Mountain States Oilseeds has previously established with wholesalers and retailers (Godfrey 2022). Without a stable flow of oilseed to the processing facilities, MSO will not be able to meet its obligations and could lose important business.

Jason understands that many barriers keep producers from planting safflower and that world economic and climate conditions play a significant role in dissuading farmer participation. Together with his leadership team, Jason has determined that the production contracts MSO uses could be rewritten to include contract mechanisms that would incentivize grower participation and stabilize the company's growing need for local safflower production. Jason now needs to determine how to maintain MSO's high-quality standards while appealing to safflower growers by reducing risk.

2 History of Mountain States Oilseeds

In the early 1970s, a representative from Ag-Pro Associates named Lowell Cook came to the American Falls region of Idaho looking to contract growers for sunflowers and safflower. One of the growers he convinced to try these new oilseed crops was Bill Meadows, a relationship that led to the first commercial production of safflower in American Falls. Unfortunately, during the first year of production, the safflower crop received herbicide spray drift from a neighboring field and struggled to produce much seed. However, the second year was successful, and storing the oilseed onsite at the farm and then marketing it in the winter proved profitable for the new crop.

In the following years, safflower began slowly growing in popularity because it used equipment similar to cereal grains like wheat and barley. Safflower also proved well suited for the dry climate of the intermountain west. The fourth year of production experienced difficulties when Ag Pro Associates, the main contractor of Idaho-produced safflower, dissolved.

Figure 1: MSO Processing Facility (Unknown. *Contact MSO*).

Despite this abrupt end to a relatively new crop contract in American Falls, a group of five farmers in the area still desired to grow safflower because of its agronomic capabilities and rotational benefits. After being denied by local grain elevators to handle and process their safflower, the group contacted the Producers Cotton Oil Corporation in California, who agreed to ship and sell Idaho-grown safflower.

When circumstances made it too challenging to organize efficient shipping of raw safflower from all five farm locations, Bill Meadows offered a different solution. By converting some property he owned along the railroad tracks and taking the responsibility as marketer and assembler of the area's safflower seed, the logistical problems of shipping to California were resolved. Thus began Mountain States Oilseeds.

Mountain States Oilseeds initially worked in partnership with Oilseed International, a San Francisco-based oilseed marketer, where MSO focused mainly on oilseed production and seed allocation. At the same time, Oilseed International oversaw sourcing and international marketing. Throughout this period, oilseed was primarily shipped to California, where it was processed and exported to Japan. During the late 1980s, MSO split away from Oilseed International to develop its own marketing strategies and gain a foothold in the newly established birdseed market.

Since its inception in 1974, Mountain States Oilseeds has continued to grow and prosper. MSO has introduced new production avenues through other oilseeds like mustard and flax. With more seed varieties available and access to larger markets, MSO has become the number one oilseed processor in the United States and one of the world's largest exporters of safflower, mustard, and flax. What began as a two-man operation has now grown to 15 employees and three locations (Mountain States Oilseeds n.d.). GMO-free safflower seed is MSO's primary product averaging 30 million lbs. per year. Belgium, Taiwan, and Mexico are the largest buyers of MSO exports (Godfrey 2022).

MSO's mission statement, "Farming for the 21st Century," elucidates their desire to serve their most important asset, growers (Mountain States Oilseeds n.d.). Their unique niche in the oilseed and intermountain west communities is specifically targeted at providing new opportunities to growers in an ever-changing agriculture marketplace and supplying nutritional foods for a healthier diet and lifestyle to consumers worldwide.

3 Crop Overview

"Safflower (Carthamus tinctorius L.) is an annual thistle-like plant in the sunflower family. It is native to Asia, the Middle East, and Northern Africa. Initially grown for dyes extracted from the flowers to be used as a coloring in food and clothing, the predominant use is now for oil…." (USDA 2016).

3.1 Uses and Cultural Practice Benefits

Safflower is harvested for three primary products: oil, meal, and birdseed (USDA 2016).

Cultivated varieties are oleic or linoleic according to the type of fatty acids they produce. Seed varieties high in oleic acid are harvested for use as a heat-stable cooking oil that is lower in saturated fatty acids than olive oil and is helpful in the prevention of coronary diseases. Those varieties high in linoleic acid are also used for human consumption in salad oils, and soft margarine and as a primary ingredient in moisturizers, soaps, and other cosmetics.

Figure 2: Crisp, White Birdseed (China Prairie. *Safflower Power!*).

As an animal feed, safflower has been valued for improving performance and efficiency in sheep, beef cattle, and dairy cattle. Though striped or partial hulls are higher in oil content, bird enthusiasts prefer crisp, white seed, which is most effectively produced in Utah, Idaho, and California due to the region's warm and dry climate (Bergman and Kandel 2019).

Though grown mainly for the food industry, new research and technological advancements are developing cutting-edge products, particularly in Australia, focused on using safflower plant matter in biodiesel and livestock forage applications.

A 2020 article published in the Renewable and Sustainable Energy Review provides compelling evidence for safflower utilization in the biodiesel market resulting in "comparable fuel properties, engine performance and emission parameters with those of diesel"(Yesilyurt 2020).

Immature safflower can also be grazed or stored as hay or silage material for livestock feed. Under normal growing conditions, immature dry matter can yield up to 3 tons per acre with acceptable fiber levels and crude protein of 8-10% (GRDC 2017). However, mature safflower is composed of a woody stalk and spiny florets, dramatically diminishing edibility and deterring livestock consumption.

Safflower is particularly popular for dryland farming. As a taproot, it does well at extracting moisture from the deeper layers of the soil, up to five feet, and is hardy in Idaho’s dry climate. The deep taproot is exceptionally effective at using limited moisture and residual nutrients throughout the soil profile. This contributes to many benefits for soil health, “including building organic matter, improving soil tilth, and promoting water percolation throughout the soil” (USDA 2016).

Safflower is used in rotation with other crops to help control grassy weeds like jointed goats-grass. Safflower is immune to herbicides that kill both grass and wheat, making it useful in wheat rotations to improve the effectiveness of chemical weed control mechanisms. The grass seed lifecycle is interrupted in a wheat-safflower-fallow cycle, and no grass emerges after six years (Pace et al. 2015).

Other benefits are noted by the Grains Research and Development Corporation as follows:

> “Safflower can be used in rotations effectively to break the lifecycle of cereal root diseases such as take-all and crown rot. It has an extensive root system, which can break up hardpans and create channels in the soil profile, facilitating air and water movement. The deep roots, combined with a long growing season, also dry soil at depth, which benefits the management of soils prone to waterlogging and salinity”(GRDC 2017).

3.2 Crop Agronomics

Safflower has a strong, woody central stem supported by a deep taproot reaching depths of 8-10 feet in some regions. Various branches emerge from the woody stem, each producing one to five florets containing up to 20 seeds per head. Flowers are generally yellow or orange, but some have white or red flowers.

Depending on the planted variety and the growing conditions, seeds will have an oil content ranging from 30-50%. Plants, on average, will grow between 12 and 24 inches in height on dryland farms and 24 to 36 inches on irrigated ground. While tolerant of dry conditions, severe drought or low soil moisture conditions during planting can severely stunt plant growth (Pace and Creech 2015).

Figure 4: Safflower Taproot (Unknown. "A Crop Profile…"

Figure 3: Immature Safflower Florets (*Unknown. Growing Safflower in Utah 2015*).

In Idaho and Utah, nitrogen is the most limiting nutrient for safflower. However, because of its deeper root depth, safflower can uptake nitrogen at 2-3 foot depths. Idaho soils typically have sufficient potassium levels, and it is recommended that soil samples be taken at depths of 0"-12" and 12"-36", testing for nitrogen, phosphorus, and sulfur (Pace and Creech 2015).

A general rule of thumb for fertilizer application in safflower is that for every 100 lbs. of seed planted, apply 5 lbs. of nitrogen (Pace et al. 2015). Fertilizer application is most effective when deep-injected preplant or drilled during sowing. If safflower is planted after a legume, like alfalfa, rather than cereal grains, required fertilizer amounts can be reduced substantially. Such rotation practices would be highly relevant to the Intermountain region, where alfalfa is popular.

Safflower is typically sown between March and May, depending on environmental conditions and whether soil moisture will allow mechanical cultural practices to occur. The Agricultural Extension at Utah State University recommends calibrating “seeding rates [at] 12 to 15 pounds per acre on dryland and 20 to 25 pounds per acre on irrigated land”(Pace and Creech 2015). Plants will begin to flower in late July, and harvesting can occur between mid-September and October.

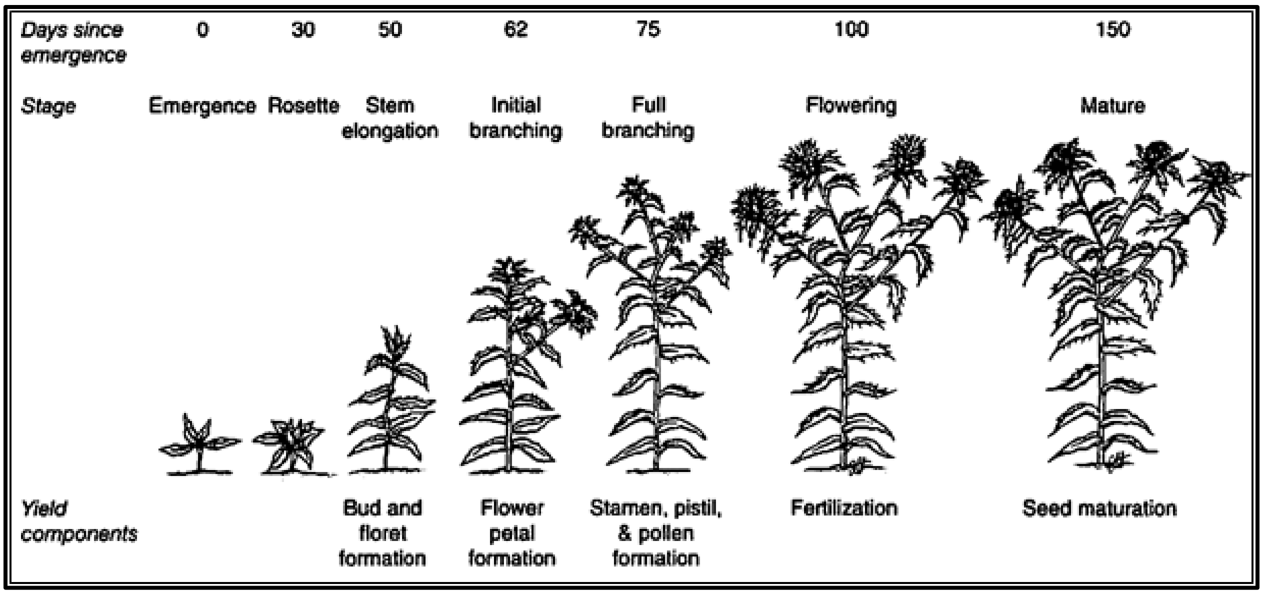


Figure 5: Stages of Safflower Development (Kaffka and Kearney 1998)

Safflower sees few insect problems that materially impact its economic performance. Cutworms, wireworms, and grasshoppers are the most significant source of damage, with the latter posing the most common risk in Utah and Idaho.

Except in years of extensive rainfall or periods of high humidity, safflower experiences few disease problems. When exposed to long-term moisture, the crop can fall prey to Alternaria leaf spot, which minimizes the plant's photosynthetic capacity and reduces yields.

4 Markets and Supply Chain

Global safflower consumption is proliferating, and the raw seed market is expected to reach a

Compound Annual Growth Rate (CAGR) of 5.7% by 2025 (Mordor Intelligence 2021). As of 2020, the United States is one of the top five producing countries, by tonnage, of raw safflower (Fig. 6), with more than 50% of production occurring in California. While popular among the Great Plains states such as Montana and the Dakotas, demand for safflower birdseed varieties grown in the Intermountain West has grown substantially over the past several years (Bergman and Kandel 2019).

4.1 World Safflower Production

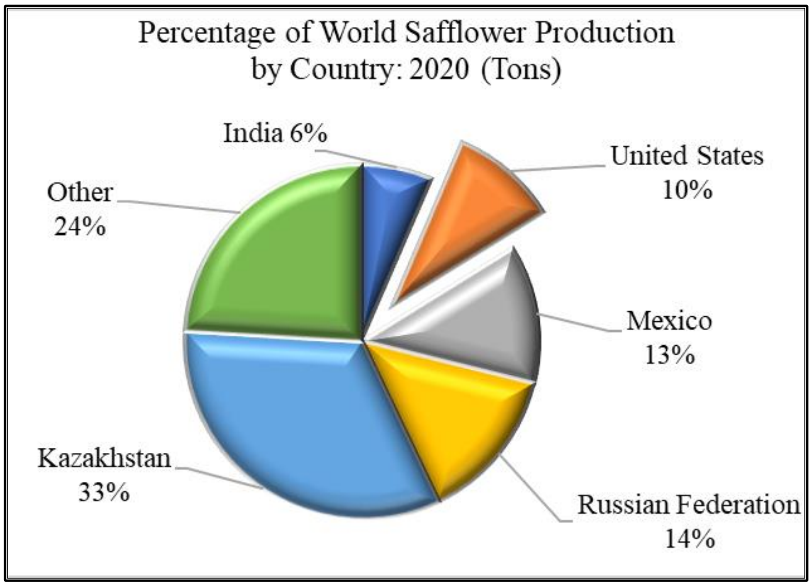


Figure 6: (Food and Agricultural Organization of the United Nations 2020)

In 2020, the Food and Agricultural Organization of the United Nations (FAO) estimated world safflower production at approximately 756,663 tons. Safflower was produced in 17 countries led by Kazakhstan, Russian Federation, Mexico, the United States, and India. These top five growing nations combine to make 76 percent of the world's safflower output (FAO 2020).

World safflower production experienced a decreasing trend from 732,524 tons in 2010 to 645,243 tons in 2019. As noted previously, 2020 saw a production increase of more than 100,000 tons. However, the FAO has yet to release production values for 2021 and 2022, which are expected to be much lower due to decreased production from war-torn Russia and Ukraine (FAO 2020).

4.2 National Import and Export Markets

In 2020, 18 percent of world safflower oil, or approximately 124,585 tons, was traded on the international market. The United States imported about 18,209 tons of safflower oil, accounting for roughly 18 percent of total U.S. production (Table 1) and 15 percent of total world safflower oil imports in 2020. The top three importing countries of safflower oil were Poland, the United States, and the Netherlands. These three countries account for over 85 percent of world safflower oil imports (FAO 2020).

In 2020 the United States exported about 11,768 tons of safflower oil, accounting for approximately 16 percent of total United States production (Table 1) and 32 percent of total world safflower oil exports. Mexico was the world's leading exporter of safflower oil, followed by the United States and the Netherlands. Combined, these three countries accounted for approximately 90% of world safflower oil exports in 2020 (FAO 2020).

Table 1. Historical United States Safflower Production

Year	Harvested Acreage	Average Yield (lbs/acre)	Total Production (lbs)	Average Price ($/lb)	Value of Production
2016	152,700	1,432	218,625,000	$0.21	$45,170,000
2017	145,200	1,212	176,025,000	$0.19	$32,725,000
2018	156,300	1,512	236,270,000	$0.20	$47,976,000
2019	151,500	1,273	192,900,000	$0.20	$38,335,000
2020	128,400	1,185	152,125,000	$0.22	$32,844,000
2021	135,000	1,001	135,175,000	$0.26	$34,418,000

Note: Price represents the price paid to producers for raw safflower seed, nominal values (NASS Quickstats 2021)

4.3 Local Safflower Market

In addition to farmers in other countries, Idaho safflower producers must compete with other states for the safflower market. United States safflower acreage and production quantities are reported sporadically by the state, and Idaho data are only reliable from about 2016 onward. California is noted by Mordor Intelligence as the dominant producer of safflower in 2021, accounting for 50 percent of the planted safflower acres (Mordor Intelligence 2021).

On average, Idaho accounts for approximately 11 percent of total U.S. safflower production. The area harvested for safflower has nearly doubled from 17,500 acres in 2016 to 31,500 in 2021 (Table 2). Because of prolonged drought, total pounds of raw safflower grown in Idaho have declined recently. For example, despite having similar harvested acreage in 2019 and 2021, the average yield per acre has dropped by 50 percent.

Table 2. Historical Idaho Safflower Production

Year	Harvested Acreage	Average Yield (lbs/acre)	Total Production (lbs)	Average Price ($/lb)	Value of Production
2016	17,500	850	14,875,000	$0.17	$2,529,000
2017	21,500	900	19,350,000	$0.18*	$3,895,500*
2018	21,000	830	17,430,000	$0.17	$2,928,000
2019	28,500	940	26,790,000	$0.18	$4,929,000
2020	26,500	880	23,320,000	$0.20	$4,687,000
2021	31,500	470	14,805,000	$0.23	$3,390,000

Note: *Data was unavailable; the ten-year Utah average was substituted (NASS Quickstats 2021)
Price represents the nominal value paid to producers for raw safflower seed.

Table 3. Historical Utah Safflower Production

Year	Harvested Acreage	Average Yield (lbs/acre)	Total Production (lbs)	Average Price ($/lb)	Value of Production
2016	13,500	810	10,935,000	$0.18*	$1,968,300*
2017	16,500	900	14,850,000	$0.18*	$2,673,000*
2018	13,000	840	10,920,000	$0.16	$1,769,040
2019	12,700	1,050	13,335,000	$0.17	$2,280,285
2020	22,000	820	18,040,000	$0.19	$3,427,600
2021	16,000	460	7,360,000	$0.22	$1,582,400

Note: *Data was unavailable; the ten-year average was substituted (NASS Quickstats 2021)
Price represents the nominal value paid to producers for raw safflower seed.

Mountain States Oilseeds has an extensive area of operation (Appendix B). Utah provides a significant portion of the raw safflower seed processed at MSO. Table 3 includes historical values relevant to MSO's strategic planning. Utah accounts for approximately 5 percent of total U.S. production.

4.4 Current Market Volatility

Global oilseed markets during 2021-2022 have vacillated because of the war between Russia and Ukraine. Russia plays a critical role by supplying approximately 14 percent of the world's safflower seed (Fig. 6). Uncertainty prevails, and it is difficult to know exactly how severe the reduction in global oilseed production will be as a result of the war.

Predictions call for rising prices as demand increases for safflower products, and the raw seed supply dramatically shifts. However, increasing costs for fertilizer formulated in Eastern Europe could offset the positive price effects. Owing to the current havoc being wreaked upon the oilseed market, it will be critical for Mountain States Oilseeds to evaluate whether recent market shocks will completely shift the long-run market or their impact will be temporary.

5 Literature Review

This study has a connection with two main threads of academic literature. The first thread involves articles and studies that examine the relationship between food production/marketing contracts and risk management. Intuitively, contracts are important for shaping and sharing risk between producers and processors. However, this study argues that it is essential to engage in contracts that do more than generically address the systematic risk that is inherent in agriculture. Instead, to precisely identify the risks of the most significant magnitude that both parties can control. The second thread is the studies using capital budgeting techniques to model the economic and agronomic benefits of enterprise diversification into the oilseed industry.

Very few studies appropriately address safflower economics and even fewer investigate the utility and limitation of contracts within the safflower economy. Ironically, nearly all safflower grown in the United States is under contract, yet little empirical analysis has been conducted to evince appropriate and effective contract mechanisms. Medical research studies primarily address the benefits of safflower products with little reference to the span between farm production and fork consumption.

5.1 General Approach to Agricultural Contracting

While there are no readily available resources for structuring safflower contracts, much has been done regarding vegetables, hogs, poultry, and sugar beets which are all saturated with contract production. Schieffer and Vassalos (2015) suggest that while a critical risk management mechanism, contracts should be viewed more broadly as a tool to help coordinate activity and manage the producer-buyer relationship.

Vavra (2009) also approached contracting from a broader perspective, concluding that the popularity of agricultural contracts is strongly tied to consolidating markets and frequent changes in technology and consumer demand. Furthermore, he explored the additional complexity of governmental regulation and policymaking related to production and marketing contracts.

Allen and Lueck (1995) sought to bridge the gap between contract theory and the realities of agricultural production, as noted by George J. Stigler: "[Such theories] have been a convenient crutch to lean on when the analysis has bogged down…They give the appearance of considered judgment, yet really have *ad hoc* arguments that disguise analytical failures."

Later they employed a utility model to illustrate the importance of how the time-honored risk-sharing paradigm of traditional contract theory could be shaped by the principal's attitude toward risk and, thus, how contract structure could be influenced under risk-averse conditions (1999). Allen and Lueck were some of the first to address the appropriate use of empirical analysis in agricultural contracts to prove contract theory.

5.2 Capital Budgets and Simulation Modeling

Yeboah et al. (2013) conducted an economic feasibility study using capital budgeting techniques programmed in @Risk simulation software to evaluate the ten-year NPV and sensitivity of oilseed biodiesel production. Similarly, Yesilyurt et al. (2020) published a comprehensive review of the potential for biodiesel production using safflower feedstock.

In analyzing project returns under conditions of uncertainty, Reutlinger (1970) proposed using probability distributions to estimate the net present value of an investment. Outlaw et al. (2007) described the net present value (NPV) as a good measure for determining the overall economic feasibility of a proposed investment. Richardson and Mapp (1976) described the probability of economic success as the probability that the NPV is greater than zero, with the reason that if the NPV>0, then the investment will yield a return (IRR) that exceeds the investor's discount rate or opportunity cost of capital.

Wilson and Dahl could be considered the modern-day Allen and Lueck regarding empirical risk analysis in the grain and oilseed markets. They employed @Risk to simulate alternative contracting strategies in Durum wheat using various pricing features and explored contract terms, analyzing them in terms of risk and return to growers using stochastic efficiency with respect to a payoff function (2011).

Wilson and Dahl (2013) also simulated grower returns and processor gross margins for alternative contracting strategies in canola production. Strategies of no contract, fixed price with and without an act of God provisions, and an oil premium contract were studied, and the resulting distributions were evaluated for stochastic efficiency. Payoff functions were defined for growers and processors that modeled the risks and returns for the accompanying pre-plant contract provisions.

5.3 Beyond the NPV: Agronomic Benefits

Smith and Jimmerson (2005) detail the economic viability of safflower resulting from its deep taproot system that gives the plant significant drought tolerance. The root system is also beneficial in wet and saline soils as the taproot opens the ground allowing airflow and surplus water movement, which promulgates low-cost, practical reclamation opportunities.

The Grain Research and Development Corporation (2017) released a safflower crop overview, stating, "As an oilseed crop, benefits include improved productivity of subsequent crops, lifting farm income, reducing the impact of disease and weeds; and producing edible and industrial quality oil and meal. Safflower integration offers the opportunity to enhance overall environmental, production, and economic sustainability."

Though little research has addressed the intricacies of risk management and contracting in the safflower industry, lessons learned in other agricultural endeavors can be suitably applied to the case at hand. Contracts have provided clear communication in many areas, cost-benefit analyses over time have been conducted on safflower products and competing oilseeds, and both economic and agronomic benefits provide incentives for the continuation of the principal-buyer framework.

6 Conceptual Framework- The Role of Contracting

"Consumers will usually choose the finished good produced by the most efficient vertical chain"(Besanko et al. 2017). Therefore, a critical management strategy must determine a firm's vertical boundaries; whether a business should perform an activity itself or outsource to another company. MSO has established its vertical boundaries by relying on independent growers to produce raw safflower seed under contract.

In order to manage the "buy" strategy employed by MSO, agricultural production contracts are used to list the set of tasks that each contracting party expects the other to perform. Such details may include the best management practices expected of the producer, identifying the commodity's quality, quantity, and payment method, and outlining the acquisition and use of resources. Contracts also specify the course of action one party may take to remedy a situation where the other party fails to meet its obligations.

> Defined: “an agricultural production contract is a legally binding agreement of a fixed term, entered before production begins, under which a producer agrees to sell or deliver all of a specifically designated crop raised on an identified number of acres in a manner set in the agreement to the contractor, and is paid according to a price or payment method, and at a time, determined in advance” (Hamilton 1995).

Farms do not operate under climate-controlled conditions. Impacts of weather, regulation, disease, and management decisions on quality and prices make agricultural products much more dynamic than goods produced in industrial manufacturing facilities. In moving agricultural commodities from farm to fork, these spastic and unpredictable conditions expose both growers and processors to risks.

Farming income is risky because it depends heavily on circumstances and conditions that are not easily controlled. Prices and output may fluctuate widely while black swan events lurk in undisclosed shadows only to appear and wreak havoc at the worst possible moments. As previously noted, the unexpected war between Russia and Ukraine has substantially changed the safflower market- both the prices and the expected global supply of safflower.

Risks matter in safflower contracting because some farmers are risk-averse and will view the production of the narrow-margin crop as a huge gamble. Many farms are also under pressure from recurring financial obligations and other planning and investment decisions. “When farmers try to avert risks by modifying production practices—changing their use of inputs such as pesticides or fertilizer, or altering cropping patterns—they affect prices, incomes, and input usage patterns” (MacDonald et al. 2004).

Despite contracts being the most widely used method in coordinating safflower production, they can lead to power or information imbalances between the parties. There is potential for monopsony power when there are few buyers of raw safflower seed. Often, processing firms will propose a printed contract that vigorously protects the interests of the processing facility and exhibits a take-it-or-leave-it mentality where there is little room for growers to negotiate terms.

However, such domineering can keep farmers from participating in the contract, and ultimately, processors may lose valuable business with wholesalers and retailers. It is essential that processing facilities draft contracts that contain mechanisms protecting the facility while incentivizing grower participation as a mutual beneficiary.

The effects of unobservable efforts on contractual efficiency can be complex. Contracts cannot entirely eliminate processor risk without eliminating the risk-sharing incentive for a farmer to participate. Similarly, protecting the producer from the consequences of risk may increase the participation incentive, but it also increases the opportunity for moral hazard. Shirking can occur when one party has no stake in the final result.

To minimize the opportunity for shirking, the elements of a complete contract should be observed: (1) the contract must be able to contemplate all relevant contingencies and agree upon a set of actions for every contingency. (2) what constitutes satisfactory performance must be measurable. (3) the contract must be enforceable (Besanko et al. 2017). Not every contingency can feasibly or economically be named and quantified; consequently, contracts are burdened by bounded rationality, difficulty specifying or measuring performance, and asymmetric information.

For a producer, contracts are beneficial as a risk management tool to reduce the inherent risks of production through risk sharing. Contract-based production offers several other benefits, such as higher profits, lower costs, and improved uniformity.

For agribusinesses like MSO, contracts improve the consistency and predictability of processing outcomes while reducing the risk of high expenditures by allowing a company to lock in a guaranteed supply to meet third-party obligations. Contracts also provide a legal means of recourse that is handled orderly and outline a clear path if either party fails to fulfill its obligations. For the consumer, “contracts can lead to reduced processing costs and provide consumers with more customized and affordable products” (MacDonald et al. 2004).

7 Analyzed Payment Structures

Production contracts can be as diverse and varied as the individuals they apply to. This project’s scope does not include an in-depth analysis of contract law beyond how it can be applied generally to production contracts used in the U.S. safflower market. It was made known in section 5, “Literature Review,” that while models attempting to illustrate the impact of contracting on risk profiles have been done, it has not been deeply explored in safflower.

The primary hypothesis explored in this model postulates that price volatility is the most influential factor determining a grower’s willingness to participate in a production contract for safflower. Contract structures that address risk beyond price volatility are only minimally considered. Thus, four standard payment methods were selected to model how the producer's risk profile of expected dollar-per-acre revenue and dollar-per-ton revenue for the processor changes under the stipulated payment conditions.

7.1 Spot Market

The spot market is a financial market where commodities, including safflower seed, are traded for immediate delivery. “Delivery refers to the physical exchange of the commodity with a cash consideration. The spot market is also known as the cash market or physical market because cash payments are processed immediately, and there is a physical exchange of assets" (CFI Team 2022). This market is typically the most volatile, and price discovery is more complicated. There is the potential to capitalize on high prices, but there is a more significant probability of downside risk and loss. Using the spot market rather than a production contract fully exposes the producer to downside price risk and the processor to upside price risk.

7.1.1 *Contract Characteristics*

- Transactions are settled at the spot price or the current market rate.
- Delivery of the assets takes place immediately.
- Transfer of funds is instantaneous.
- Price is not fixed until assets exchange hands; higher probability of negative returns.

7.2 Fixed Price Performance Payment

A contract mechanism often used in oilseed markets where contracts are created at the beginning of each year, and the processor and the producer agree upon price per lb. By fixing the price, downside price volatility is removed from the grower, and the risk of their profit function hinges upon cost and yield risks instead. The processor may, however, impose quality constraints in the contract that allow some price adjustment for yields that do not meet the quality standard.

Fixed price payments are popular because they eliminate downside price risks, and the producer can estimate end-of-year revenues more predictably by yield. Conversely, significant market price changes can render contracts untenable for one party. During periods of low market prices, the processor may have a solid incentive to void or renege on the contractual commitment, while the inverse is valid for the producer in times of high market prices.

7.2.1 *Contract Characteristics*

- Simple and clear, the price to be paid/received is known early in the year.
- Shared risk profile.
- May require additional contract mechanisms to meet quality requirements.
- Higher chance of renegotiation if prices experience much movement.

7.3 Indexed Price Performance Payment

Safflower does not have a futures market, and price discovery is difficult. Using an indexed payment, one can easily estimate safflower prices given a historical average or standardized price indexed against a commodity with more information transparency. This project indexes safflower prices against wheat prices, considering that most farms in Utah and Idaho will likely replace dryland wheat production with safflower when making the enterprise change.

Rather than establishing the price at the beginning of the year as in a fixed price contract, indexed prices can move with correlated changes in other commodities. In a sense, price renegotiation is fundamentally built into the contract such that neither party is incentivized to breach the contract because of changes in the market.

Some such agreements also establish high and low thresholds beyond which the contract cannot go, thereby giving flexibility for price adjustments in the market yet still protecting either party from downside risk. This project models an indexed price performance payment structure without bounds. The concept of a bounded index payment structure is further addressed in Section 11.

7.3.1 *Contract Characteristics*

- Flexibility allows prices to move, improving the profit potential for both parties.
- More downside risk without thresholds.
- Prices are tied to other commodities, so market shifts are much more impactful.
- Price is tied to performance indicators, and renegotiation risk is minimized.

7.4 Combination Lump Sum and Fixed Price Payment

Rather than determining revenue only as a function of price times quantity of the commodity produced, the lump sum payment is paid on a per-acre basis. Whether delivered yearly or as an establishment payment, this contract provides revenue to the producer regardless of the field's performance.

Its appeal comes when periods of low planted safflower acreage jeopardize the quantity of raw safflower seed entering the mill. Acreage payments can also promote oilseed production by drawing farmers who have not previously rotated safflower by providing a percentage of guaranteed income.

Price and yield risks are removed from the producer and transferred to the processor. As a processor, the firm may take on more risk, especially when moral hazard is created because the acreage payments are not tied to performance objectives. However, lump sum payments are effective at pushing more acreage into safflower production, thereby increasing the odds of having a sufficient seed supply.

Since a strict lump sum contract mechanism violates the moral hazard constraint held by Mountain States Oilseeds, this project introduces a combination contract mechanism that pays a 10 percent fixed acreage payment of $24.72 per acre and then pays the farmer a fixed price of

$522.67 per ton thereafter. Furthermore, the contract is structured such that the producer payoff is reevaluated at the end of the year once yields are known. MSO can scrutinize growers who yield less than the expected average of 0.41 tons per acre to determine whether a new contract will be enacted for the following year. An additional payment is made to farmers who experience yields greater than the expected average, thus incentivizing best management practices.

7.4.1 *Contract Characteristics*

- Reduces price and yield risk for the grower.
- Can shore up safflower production when the expected production acreage is low.
- Simple and direct structure that can be adjusted with other mechanisms.
- Can inadvertently create situations of asymmetric information and moral hazard.

8 Quality Adjustments

MSO supplies non-GMO safflower to retailers and wholesalers. Thus, any seed entering the facility must also comply with non-GMO standards. Planted seeds must be GMO-free, and the harvested oilseed must be free from GMO contamination by other crops and cultural practices. The land should be clean and free of trash and debris. All equipment and storage facilities should be cleaned appropriately during all phases of the safflower production period to avoid any food safety liability.

To help reduce the risk of contamination, growers who contract with MSO must either purchase seed previously inspected by MSO or use seed provided by MSO for that purpose. Moreover, appropriate multi-year crop rotation practices should be followed to protect the crop from other GMO crops, contamination, cross-pollination, and inseparable seeds.

Safflower seed contracted and shipped to MSO must also comply with the moisture and dockage requirements as outlined in Table 4. Using a quality scale to monitor moisture and dock material within the incoming safflower loads reduces the amount of waste and cost at the processing plant. Raw seed with high moisture levels, excessive dirt, or dockage must undergo drying and cleaning procedures before the seed is ready for processing.

Prospect Theory suggests that "when choosing among several alternatives, people avoid losses and optimize for sure wins because the pain of losing is greater than the satisfaction of an equivalent gain" (Harley 2016). In other words, a method of impending price reductions for a low-quality product is much more effective than the inverse method of premium additions to achieve that same quality.

Table 4. Safflower Quality Deductions

Safflower Cleaning Charges by Short Ton (ST)			
Total Dockage- includes other grains and sprouts	**Cleaning Charge**	**Moisture**	**Discount**
0.00-5%- No charge, but all dockage will be deducted from the gross inbound weight		8.0-9.0%- No charge but subject to acceptance by MSO	
5.1-6%	$8.00/ST	9.1-10%	$6.00/ST
6.1-10%	$10.00/ST	10.1-11%	$12.00/ST
10.1-12%	$12.00/ST	11.1-12%	$18.00/ST
12.1-15%	$15.00/ST	12.1-13%	$24.00/ST
15.1-17%	$18.00/ST	Any seed in excess of 13% moisture will only be accepted by negotiation.	
17.1-19%	$22.00/ST		
19.1-21%	$25.00/ST		
21.1-22%	$28.00/ST		
All charges are against gross inbound weights.			

Note: For more information, see "Appendix F"

Decreasing the price paid per ton for safflower seed below the preferred quality thus galvanizes farmers to ameliorate their efforts. Producers also gain access to MSO crop advisors and other professionals through the contract, who can calibrate farm equipment before harvest to achieve optimal quality. By using a production contract strategy, MSO can more easily adhere to the quality and GMO constraints of wholesalers and retailers to fulfill its consumer obligations downstream.

9 Model and Methods

A stochastic cost-benefit model was developed to test how different payment mechanisms influence the total risk profile for growers and processors of safflower. The price payoff function is a mechanism-based model that incorporates the dynamic elements of safflower production by simulating price uncertainty, cost fluctuation, and crop yield predictions that more accurately reflect the relationship between the price received by farmers and the overall riskiness of the enterprise.

While the model only evaluates cashflows for one year of safflower production, discounted future cashflows are incorporated to differentiate the time value of money for cashflows occurring at the beginning and end of the contract period. Several benefits arise from this model assumption, including enabling objective comparison. Comparing payoff values across varying companies, investments, and objectives becomes much more accessible, giving consistent valuation across many scenarios. In this case, only a few contract designs are considered. However, there is a practical use for this compatibility as research continues and future projects begin to evaluate safflower as a substitute relative to other cash crops.

Two, the assumption of discounted future flows assays the passage of time between initial planting when costs are primarily incurred and harvesting, when payment is finally received. Discounted flows provide a means to account for and quantify the uncertainty when a farmer first makes his planting decision and enters a contract with MSO at the start of the year. Because safflower historically has had such thin margins, the production risks between planting and harvest become much more poignant as a farmer considers his enterprise budget.

Three, a discounted cashflow model allows for improved sensitivity analysis where changes in the stochastic elements of the model over time can be appraised for their impact on the final expected payoff value. This is perhaps the most compelling advantage of using discounted cashflows because the specific contract payment mechanisms evaluated in this study become particularly impactful when gauged by their ability to mitigate downside risk and improve the level of producer risk exposure given marginal changes in the most sensitive variables.

For the model, price and yield data were obtained from the USDA database for the past 20 years of safflower production on average across the U.S. Data specific to Idaho is sporadic at the writing of this paper; therefore, price and yield were adjusted by an average basis percentage to account for geographical differences calculated from the available data for both regions. Costs were retrieved from the 2019 USU Extension safflower crop budget and modeled stochastically under a triangular distribution (Pace et al. 2019).

All simulated mechanisms are evaluated relative to the spot market model. This includes the constraint imposition that all simulated contract payments are first standardized to $600.00 and then transformed by the individual mechanisms, thereby giving clear interpretations of changes to the risk profile and expected NPV payoff function for either party.

It was assumed that yields, costs, and other influencing factors are not significantly impacted by entering a contract. Casaburi et al. (2014) and Arouna and Michler (2021) both attempted to disclose the relationship between agricultural productivity and contract farming, but both focused on farm systems in rural, foreign scenarios. MSO believes productivity is far more correlated with producer characteristics than contractual obligations and does not collect primary data on this issue (Godfrey 2022). Little empirical or anecdotal evidence is available to suggest enhanced complexity; therefore, to abide by the principle of Ockham's Razor, this model implements the same stochastic costs and yields *ceteris paribus* across all contract types such that marginal changes in risk or NPV can be specifically attributed to the simulated payment mechanism.

9.1 Grower Payoff Functions

For growers, the payoff functions were defined as net present value returns per acre over one year. Grower payoffs according to payment mechanism alternative were defined as follows for spot market or no contract (Eq. 1), fixed price performance payment (Eq. 2), indexed price performance payment (Eq. 3), and a combination lump sum and fixed price payment (Eq. 4). It is assumed that producers have available acreage and the appropriate equipment to participate in this enterprise.

(1)

$$NPV_{(Spot\ Market)} = \sum_{T=1}^{n} \left[\frac{((P_T - Mf_T - Df_T) * Y_T) - C_T)}{(1+r)^T} \right] - (C_{T-1})$$

where:

P_T is the expected safflower price per ton using a fitted normal distribution with μ \$600.00 per ton and σ \$106.01. Y_T is the expected safflower yield tons per acre following an independent draw from a fitted extreme value minimum distribution with μ 0.41. and σ 0.055. Mf_T is the moisture fee deducted for raw safflower with high moisture content that is received at the MSO facility. This fee follows an independent draw from a triangular distribution with a minimum of \$0 and a maximum of \$24 per ton with a most likely value of \$0. Df_T is the dockage fee deducted for raw safflower dockage, other seed, and dirt content in raw safflower received at the MSO facility. This fee follows an independent draw from a triangular distribution with a minimum of \$0 and a maximum of \$28 per ton with a most likely value of \$0. C_T is the expected cost per acre incurred at the end of the period. Costs at time T follow an independent draw from a normal distribution with μ \$102.77 and σ \$9.51. C_{T-1} is the expected cost per acre incurred at the beginning of the period that is not discounted. Costs at time *T-1* follow an independent draw from a normal distribution with μ \$81.96 and σ \$7.30. Cost distributions were fitted to the USU Extension crop budget. Each line item was modeled stochastically as triangular distributions with min -50 percent and a max of 50 percent variation from the given budget value. Most likely cost values are the expected costs as expressed in the enterprise budget. *r* is the discount rate fixed at 15 percent for the producer. *T* is the number of cash flow periods equal to 1 in this model.

(2)

$$NPV_{(Fixed\ Performance\ PMT)} = \sum_{T=1}^{n} \left[\frac{(((Pf_T - Mf_T - Df_T) * Y_T) - C_T)}{(1+r)^T} \right] - (C_{T-1})$$

where:

Pf_T = \$600.00 fixed price per ton. All other variables, as defined in Eq. 1.

(3)

$$NPV_{(Indexed\ Performance\ PMT)} = \sum_{T=1}^{n} \left[\frac{\left(\left((Ps_T - Mf_T - Df_T) * Y_T\right) - C_T\right)}{(1+r)^T} \right] - (C_{T-1})$$

where:

$$Ps_T = \left(Pf_T * \frac{Pw_T}{Pw_{T-1}}\right)$$

Ps_T is the calculated safflower price that has been indexed to wheat. Pw_T is the price of wheat at time *T* following a random walk under a fitted RiskGARCH time-series model developed from 20 years of historical data. The time-series model includes a correl matrix to adjust for a 0.82 correlation between safflower and wheat prices and has been detrended to remove any price bias.

Pw_{T-1} is the previous year's price. After comparing several autoregressive models using the past 20 years of wheat price data, it was determined that only wheat prices the year prior were statistically significant at the 1 percent level. An AR-1 model is the most appropriate method of developing the wheat price index.

(4)

$NPV_{(Combo\ Lump\ Sum\ and\ Fixed\ Price\ PMT)}$

(4.1)

$$= \sum_{T=1}^{n}\left[(\theta) * \left(\frac{\left(\left((Pf_T * Y_T * 0.9) - \left((Mf_T + Df_T) * Y_T\right)\right) - C_T\right)}{(1+r)^T} - (C_{T-1}) + (A_{T-1})\right)\right]$$

(4.2)

$$= \sum_{T=1}^{n}\left[(1-\theta) * \left(\frac{\left(\left((Pf_T * Y_T) - (A_{T-1}) - \left((Mf_T + Df_T) * Y_T\right)\right) - C_T\right)}{(1+r)^T} - (C_{T-1}) + (A_{T-1})\right)\right]$$

where:

$If\ Y_T \leq 0.41\ then\ \theta = 1$. Producer payoff NPV is calculated using Eq. 4.1.

$If\ Y_T > 0.41\ then\ \theta = 0$. Producer payoff NPV is calculated using Eq. 4.2.

A_{T-1} is the acreage payment calculated as $A_{T-1} = ((Pf_T * 0.41) * 0.1)$

9.2 Processor Payoff Functions

Processor payoffs were defined as the net present value returns per ton of safflower regardless of the final processing state, which includes birdseed, meal, and oil. Due to the difficulty of establishing reliable data, it is assumed that MSO is risk neutral unless otherwise specified. It is also assumed that the processing facility and accompanying machinery have already been established, and no initial investment is modeled in the cash-flow table. The discount rate was held constant at 10 percent.

Processor payoffs according to payment mechanism alternative were defined as follows for spot market or no contract (Eq. 5), fixed price performance payment (Eq. 6), indexed price performance payment (Eq. 7), and a combination lump sum and fixed price payment (Eq. 8).

(5)

$$NPV_{(Spot\ Market)} = \sum_{T=1}^{n} \frac{(Pps_T - \left(\frac{Ppp_T}{Y_T}\right) - Oc_T)}{(1+r)^T}$$

where:

$Ppp_{\boldsymbol{T}} = (P_T - Mf_T - Df_T) * Y_T)$

Pps_T is the price received for processed safflower from wholesalers and retailers following a triangular distribution with a min \$800, a max of \$1200, or approximately 20 percent volatility, and a mean expected value of \$1000 per ton. Ppp_T is the price paid to the producer for raw safflower seed \$/acre. Oc_T is the operating cost of processing safflower at the mill following a triangular distribution with a min \$125, max \$375, or approximately 50 percent volatility, and an expected mean value of \$250 per ton, all other notation as outlined in Section 9.1.

(6)

$$NPV_{(Fixed\ Performance\ PMT)} = \sum_{T=1}^{n} \frac{(Pps_T - ((Pf_T - Mf_T - Df_T) * Y_T) - Oc_T)}{(1+r)^T}$$

(7)

$$NPV_{(\ Indexed\ Performance\ PMT)} = \sum_{T=1}^{n} \frac{(Pps_T - \left(\frac{Ppp_T}{Y_T}\right) - Oc_T)}{(1+r)^T}$$

where:

$Ppp_{\boldsymbol{T}} = ((Ps_T + R_T - Mf_T - Df_T) * Y_T)$

Note: Observe the change from the price distribution P_T in Eq. 5 to the price distribution Ps_T.

(8)

$NPV_{(Combo\ Lump\ Sum\ and\ Fixed\ Price\ PMT)}$

(8.1)

$$= \sum_{T=1}^{n} \left[(\theta) * \left(\frac{\left(Pps_T - \left((Pf_T * Y_T * 0.9) - ((Mf_T + Df_T) * Y_T)\right) - Oc_T\right)}{(1+r)^T} - (A_{T-1})\right)\right]$$

(8.2)

$$= \sum_{T=1}^{n} \left[(1-\theta) * \left(\frac{\left(Pps_T - \left((Pf_T * Y_T * 0.9) - (A_{T-1}) - ((Mf_T + Df_T) * Y_T)\right) - Oc_T\right)}{(1+r)^T} - (A_{T-1})\right)\right]$$

where:

$If\ Y_T \leq 0.41\ then\ \theta = 1$. Processor payoff NPV is calculated using Eq. 8.1.

$If\ Y_T > 0.41\ then\ \theta = 0$. Processor payoff NPV is calculated using Eq. 8.2.

All other notations are as previously outlined.

10 Simulation Results

Variability in net returns results from yield, price, and cost risk, with some price movement attributable to quality constraints. Stochastic simulation in @Risk (Palisade Corp. 2022) was used to simulate the alternative contracting strategy payoffs for safflower growers and processors in the Intermountain West.

For both parties, a cash flow summary table was created for each of the four contract structures to simulate safflower payoff NPV under the alternative contracting constraints over one year (Appendix C, Appendix D). The cumulative density function output graphs (Fig. 7 and Fig. 9) and the summary statistics found in Table 5 were used to compare contract structures to determine which best minimized risk, renegotiation, and moral hazard while observing the constraints and maximizing profits for both the producer and Mountain States Oilseeds. Recall that the first objective is to minimize downside risk, and the second is to maximize upside potential.

10.1 Results Overview

The spot market or no contract scenario is the base case where no payment mechanisms or contracting constraints are imposed upon either the farmer or MSO. All other simulated mechanisms are evaluated first relative to the spot market model and then to the other alternatives.

Table 5. Simulation Output Statistics: Producer and Processor NPV Payoff Distributions Under Various Contract Scenarios

	Producer Distributions ($/Acre)				Processor Distributions ($/Ton)			
	Spot Market	Fixed Pmt.	Indexed Pmt.	Combo Lump Sum	Spot Market	Fixed Pmt.	Indexed Pmt.	Combo Lump Sum
Mean	$34.78	$34.75	$44.13	$39.07	$152.12	$152.12	$128.50	$144.19
S.D.	$48.70	$30.23	$50.89	$28.42	$129.82	$88.48	$132.69	$88.04
Prob. NPV<0	23.2%	12.1%	19.2%	8.9%	12.1%	4.4%	16.6%	5.3%
Min.	-$157.43	-$154.39	-$165.80	-$129.93	-$297.97	-$107.57	-$369.56	-$118.50
Max.	$232.25	$114.31	$229.53	$109.62	$611.95	$411.51	$530.86	$412.53
Skew.	0.0309	-0.9136	0.0272	-0.7556	0.0217	0.0137	-0.0104	0.0351
Kurt.	3.0831	4.5623	3.4521	4.7114	2.9304	2.6262	2.9110	2.7384
1%	-$79.41	-$58.04	-$72.98	-$44.49	-$149.29	-$43.56	-$180.66	-$54.69
5%	-$45.62	-$20.66	-$38.46	-$12.16	-$63.16	$6.00	-$87.16	-$1.41
10%	-$26.46	-$4.43	-$20.20	$2.24	-$14.68	$36.02	-$42.82	$32.39

10.2 Producer Analysis

Expected returns were highest for the producer under the combination lump and fixed price payment at $39.07 per acre. Variability was lowest for that payment structure (SD=$28.42/acre) and greatest for the indexed price performance payment (SD=$50.89/acre). It is also high for the spot market scenario (SD=$ 48.70).

Distributions for a producer using alternative payment structures were negatively skewed under the fixed price payment and the combination payment contract conditions. Defined: the more negative skewness a distribution exhibits, the more likely it is to achieve a return lower than the mean. There is a lower probability of receiving large payments from the right tails of their respective distributions for these two contracts. The fixed performance price and the combination payment had a kurtosis above 4, suggesting that these distributions tended to be more spiked than a normal distribution. Distributions with more kurtosis are more likely to draw values near the mean. Therefore, both structures exhibit less upside opportunity but do well at reducing downside risk and increasing the likelihood of payoff values near the mean.

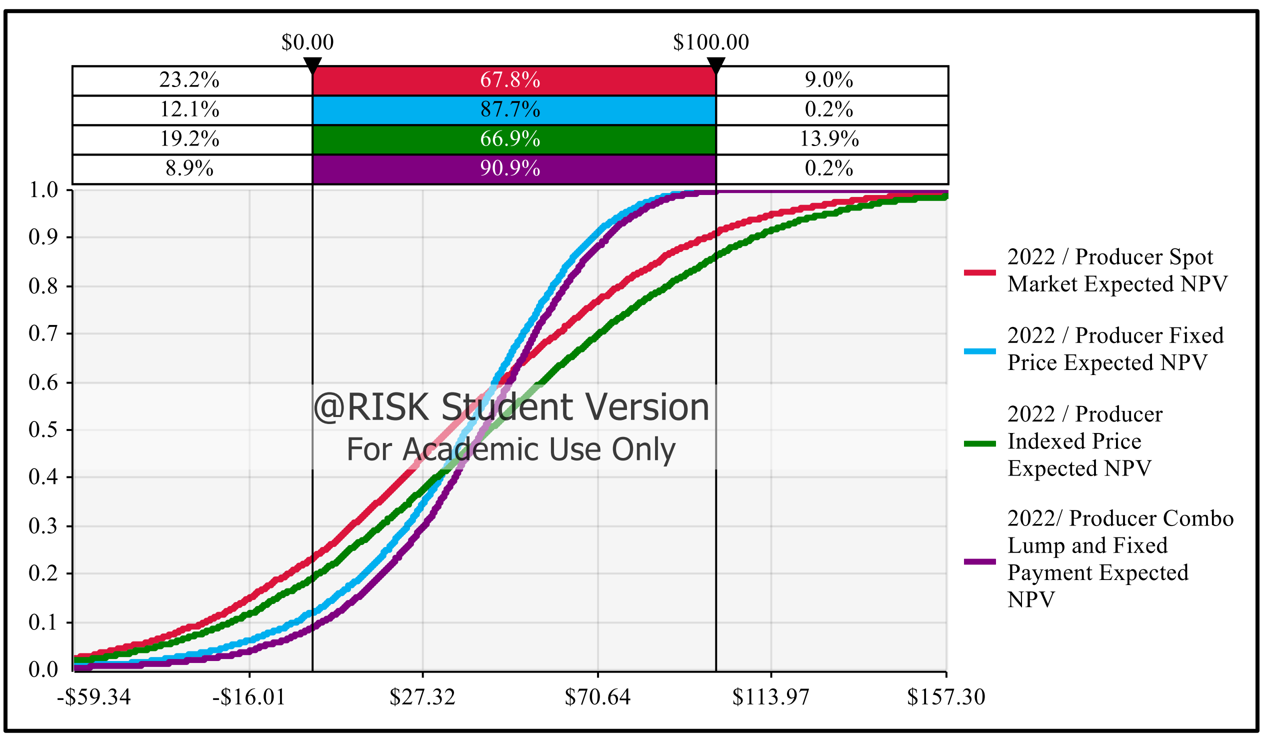


Figure 7: Producer Expected NPV $/Acre Payoff Distribution Comparison

Growers, in this case, are assumed to be risk-averse. Consequently, the combination lump sum and fixed price contract could conceivably be the most acceptable based on the minimized NPV variation of σ \$28.42 and an 8.9% probability of returns less than \$0. It also gives a higher expected payoff amount per acre than either the fixed price or spot market scenarios. While the indexed contract may offer more considerable topside opportunities, the combo structure has the best per-acre returns on average for the least amount of downside risk and price volatility.

Paradoxically a lump sum payment may introduce a slight chance of moral hazard where the producer is not incentivized to implement best management practices. However, this contract structure provides compelling evidence that further investigation is required. The combination contract successfully mitigates price risk. It also provides insurance against yield risk for the producer, persuasively contending for MSO's consideration. Given the uncertainty surrounding the implementation of a combination contract, and the nearly identical downside risk-shaping

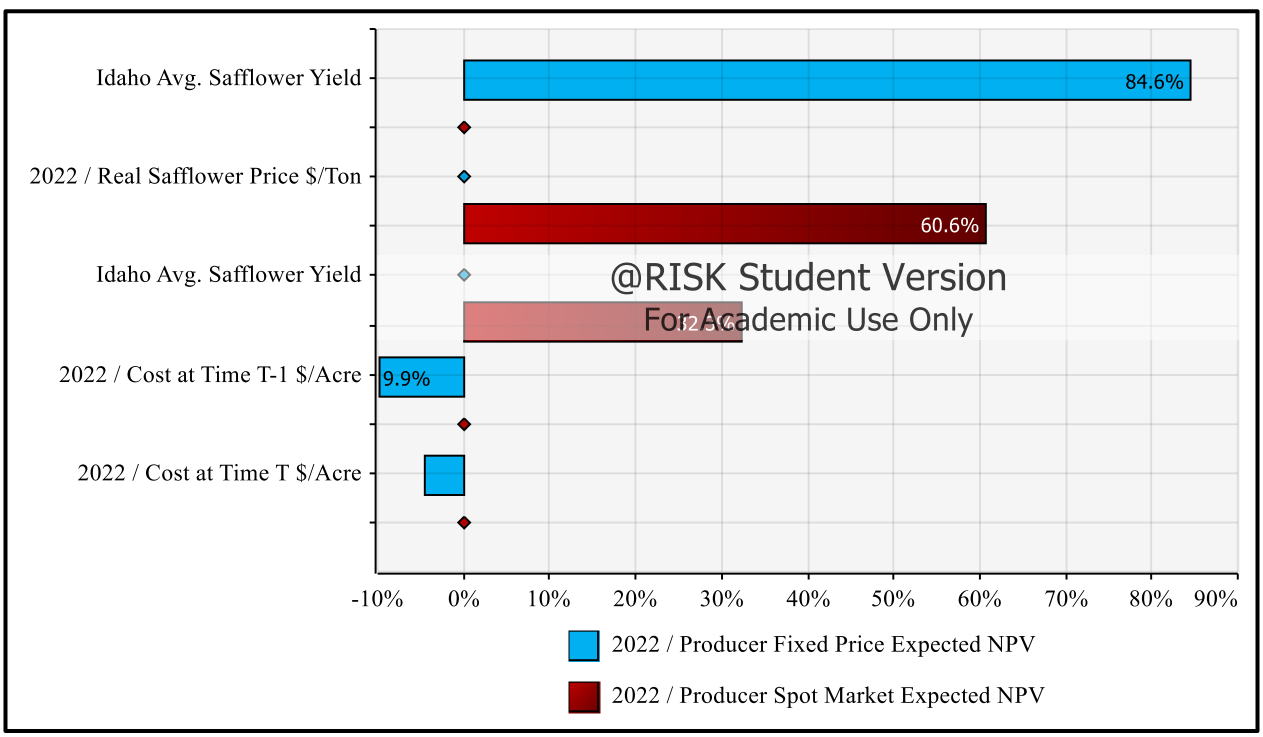


Figure 8: Producer Fixed Price Performance Payment Change in Contribution to NPV Variance

capability of the fixed price performance payment, the latter contract is the best option for the producer in this study.

Figure 8 illustrates how each variable’s contribution to NPV variance changes between a producer selling on the spot market and one using a fixed price contract. Most significant is the reduction in price volatility. A grower selling raw safflower seed on the spot market can expect 60.6 percent of their expected payment per acre change to be attributable to 2022 safflower seed prices $/ton. By fixing the price to $600.00 per ton, MSO can eliminate price uncertainty for the producer. Payoff outcomes are then dependent on other stochastic risks, and safflower yield per acre becomes the most impactful determinant of the grower’s expected NPV payoff, which places the profitable success of the enterprise squarely on the shoulders of the operator.

Moreover, this structure also minimizes the probability of moral hazard because payoffs are directly tied to performance objectives. Nevertheless, there is some renegotiation risk because the plasticity of the spot market is firmly truncated through the proposed mechanism. Though protected from significant losses because of the provisional price floor, weighty market changes not foreseen at the signing of the contract could be the impetus for paltered contract terms. In reality, this concern is inconsequential. Predicated on the current safflower processing landscape where there are few processors, and the producer has little negotiating power.

The indexed price performance payment initially appears promising, with an NPV of $44.13, almost $10.00 more than the spot market scenario. The indexed contract is stochastically more efficient than selling seed on the spot market because safflower prices are subject to the market attributes of wheat, which has more extensive upside opportunities. Upon closer inspection, it is clear that the indexed structure also introduces more price volatility to safflower with a $2.19, or

4.22 percent, increase in the standard deviation. The downside risk is only minimally impacted, making the fixed price contract much more attractive to the risk-averse grower.

10.3 Processor Analysis

The processor's expected net present returns were highest under a fixed price performance payment at $152.12 per ton. Variability was lowest for the combination lump sum and fixed price payment (SD=$88.04) and most significant for seed purchases made under the indexed price performance contract (SD=$132.69). The spot market also experienced high variability (SD=$129.82).

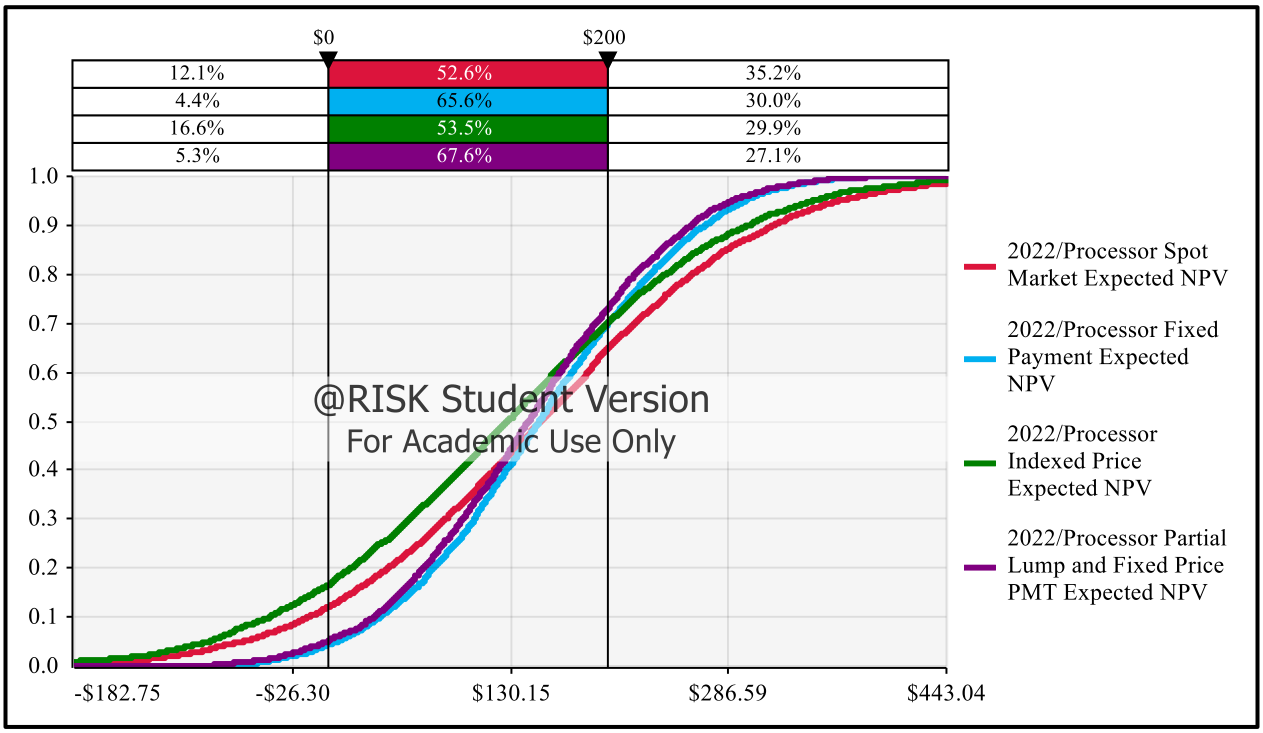


Figure 9: Processor Expected NPV $/Ton Payoff Distribution Comparison

Except for the indexed price, distributions for the processor under alternative contract structures were all positively skewed. In all scenarios, kurtosis was valued near 3, suggesting that the output distributions were shaped no more or less differently than a normal distribution.

Because the index contract ties raw safflower seed prices directly to wheat prices, it is crucial to understand how wheat prices have moved historically. While one cannot perfectly predict the future, the fitted distributions illustrated in Figure 10 concisely depict what movements processors and producers can expect on average from wheat prices.

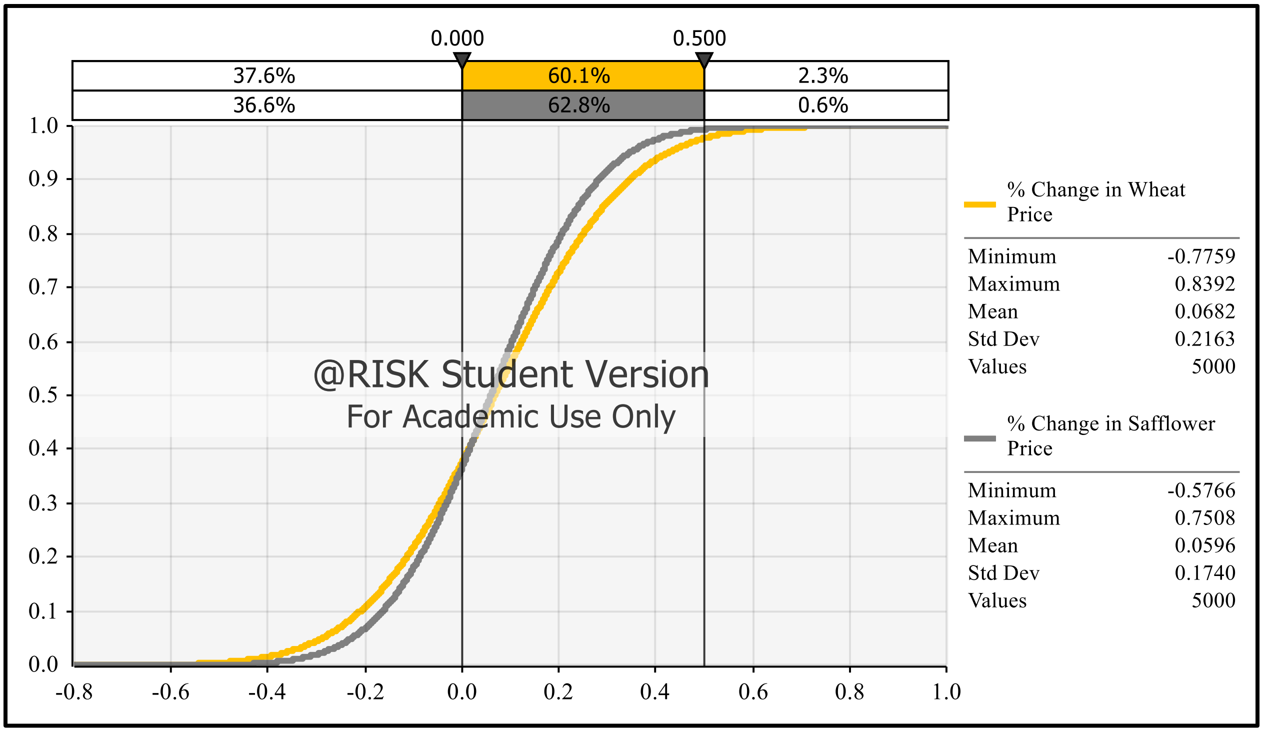


Figure 10: Comparative CDF of Historical Percent Changes in Wheat and Safflower Prices

The CDF Figure 10 indicates a better than 60 percent chance that wheat prices will move higher; thus, the indexed payment favors the producer, but there is still a 37.6 percent chance that prices will drop, which favors Mountain States Oilseeds.

For the processor, the indexed contract provides lower downside risk protection than the fixed price contract because the firm is taking on a higher proportion of the price risk relative to the producer. MSO is looking to incentivize grower participation in safflower production. Therefore, the indexed payment does not sufficiently provide against downside risk and price volatility, and other contracts are found to be superior.

For Mountain States Oilseeds, the fixed performance price contract effectively reduces volatility by 7.7 percent relative to the spot market while maintaining a positive expected NPV. It is an excellent option to protect the processor from unexpectedly high prices, meaning that downside risk is secured. A combo lump sum, fixed price structure can result in similar returns, making it a strong candidate for consideration. Once again, due to the theoretical uncertainties that exist in the combination contract, it is left for future investigation.

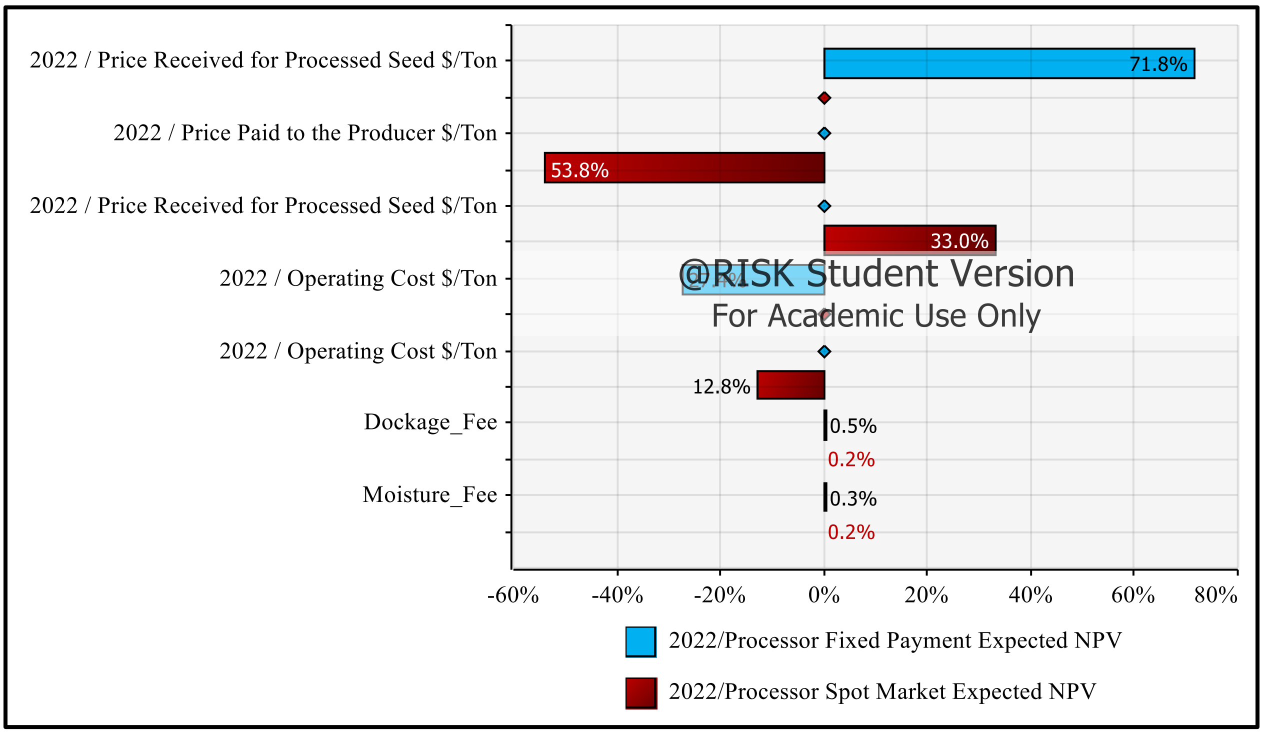


Figure 11: Processor Fixed Price Performance Payment Change in Contribution to NPV Variance

The fixed price performance payment is the preferred choice for Mountain States Oilseeds. As the preferred contract mechanism for producers, it will be easier to obtain sufficient safflower seed quantities to keep the mill running and fill wholesale orders while also controlling the downside risks inherent in purchasing on the spot market. Figure 11 illustrates the changes effected on NPV variance by engaging in the fixed contract relative to the spot market.

11 Future Research Efforts

This study aimed to identify the risks faced by both the processor and producer and to select a contractual design mechanism to minimize those risks and maximize profit under the specified conditions. Mountain States Oilseeds established the primary objective to incentivize grower participation. Thus, this model assumed that MSO would remain risk neutral unless otherwise specified. Based on that assumption, it was hypothesized that because safflower exhibits such thin margins, price risk would be the farmers' most significant shaper of the output distribution. Emphasis was placed on pricing mechanisms within the contract that would reduce price risk for the grower.

11.1 Approach to Price, Yield, and Cost Risk

The model illustrated that yield differences between safflower production in the Great Plains and California areas versus the Intermountain West are highly significant. Under a spot market scenario where no contract is employed, 32.4 percent of the expected NPV variation for safflower production is attributable to yield basis due to geographic location. Historically, Idaho has experienced a -38 percent average yield differential relative to the most recent 10-year national average.

Furthermore, costs incurred 4.5 percent of the NPV variation. Though price volatility significantly contributes to NPV variation at 61.6 percent, the combined cost and yield risks still account for 37.1 percent of total safflower production volatility. Thus, the initial expectation that prices would drive NPV risk for safflower was correct. However, instituting alternative price mechanisms that reduce yield and cost risks can have a measurable impact on the economic viability of safflower production.

Further investigation is necessary to adjust MSO's contract strategy to comprehensively address the risks in resource-scarce locations. Potential avenues of study could include (1) implementation of educational programs teaching safflower best management practices to improve the effectiveness of resource allocation, (2) input subsidization by MSO to reduce grower costs and improve marginal revenue, (3) contracting for higher processed safflower prices with wholesalers and retailers because of Idaho's comparative advantage in producing birdseed quality safflower.

This model did not assess a risk premium for the transfer of risk from the producer to Mountain States Oilseeds. Due to the thin margins experienced by safflower growers, risk premiums could only be exacted at a few dollars before contracts became undesirable for grower participation. While producers were extremely sensitive to changes in risk premiums, MSO was not. It was determined to remove risk premiums from the model as they tended to obscure the results. Further research should be conducted to model how Mountain States Oilseeds might be compensated for taking on the largest share of the price-risk burden.

11.2 Utility Theory

An area of research that could prove immensely beneficial to the study of contracting in safflower is the addition of the subjective expected utility theory (SEU). The theory characterizes the qualitative behavior of decision-makers concerning the attractiveness of an economic opportunity as perceived in the presence of risk.

This paper made the simple yet naïve assumption that all safflower growers are risk averse and all processors are risk neutral. The results were then applied to select the payment mechanism that most effectively reduced grower risk while maintaining the conditions necessary for MSO to meet the constraints of its wholesale contracts. Under the SEU, the model could more dynamically approach the question of contract choice.

Furthermore, a stochastic dominance with respect to a function (SDRF) framework could be employed to analyze the simulation cumulative density functions and order risky alternatives by their certainty equivalents, the same as partial ordering by utility values. Hardaker and Lien (2003) provide a concise approach to stochastic efficiency analysis methods with risk aversion bounds. Wilson and Dahl (2011) compared net return distributions utilizing the stochastic efficiency with respect to a function (SERF) method to "determine risk-efficient rankings and to examine effects of risk aversion on preferences."

11.3 Expanded Contract Provisions

The alternative payment mechanisms investigated hitherto are by no means an exhaustive list of potential contract structures. The scope of the paper was an attempt to understand various standard payment forms and their broad relationship to price risk. Understanding how they each interact with safflower prices generally facilitates more nuanced contract development centered on the geographical, economic, and financial feasibility attributes of the Intermountain area.

The model found that a fixed price performance payment had the highest expected NPV and was the most effective at reducing NPV variation for producers and processors. Alternatively, one could define a contract with a min/max provision for the price spread instead of fixing the price level. No formal futures market exists, and virtually no research has been conducted on crosshedging optimality in safflower. Consequently, the suggested hypothetical contract would synthetically introduce put and call options that exhibit the flexibility of an indexed price while protecting both producer and processor from extreme highs and lows.

Real-world safflower contracts are negotiated at the beginning of each production year. Producers can quickly move in and out of safflower production from year to year, in some regions, several times throughout the year. A real options analysis could prove supremely beneficial to the current model as it would assess the impact of periodical renegotiation commonly expected in the industry. Du and Hennessey (2011) provide a clear structure for evaluating real options in land rent contracts by applying Monte Carlo simulation techniques.

11.4 RMA Crop Insurance

The Risk Management Agency (RMA) is the crop insurance arm of the USDA. Crop insurance has become an important risk management tool in modern-day agriculture. This paper included stochastic costs for producer participation in the Noninsured Crop Disaster Assistance Program (NAP), which covers low yield, loss of inventory, or prevented planting caused by natural disasters. Nevertheless, assumed costs are negligible at $1.24 an acre, and this model did not attempt to address insurance payouts under adverse conditions.

As noted in Section 11.1, lower yields in the Intermountain region provide a significant source of volatility. The RMA offers several other insurance products that might be explored to resolve other production risks such that farmers are more likely to add safflower to their enterprise rotations. Though MSO does not supply insurance products, education on the current USDA programs could improve the buyer-producer relationship and give Mountain States Oilseeds an edge over competitors in the contracting process.

12 Conclusion

Challenging economic and climate conditions have Jason Godfrey and Mountain States Oilseeds searching for innovative ways to secure a steady supply of quality raw safflower seed to their processing facilities. Preplant agricultural contracts have always played a role in safflower production, but contract mechanisms that are empirically tested and theoretically supported are becoming more critical in the current agricultural environment.

Factors contributing to increased instability for MSO include reduced global seed supply and increased production costs from war-torn Eastern Europe, climate change and constricting water availability, urban creep and the loss of productive acreage for which intercrop competition is intense, and crop rotation traditions fiercely held by a farm ownership demographic averaging 60 years old (Census of Agriculture 2017).

This study aimed to develop a model to analyze alternative contracting strategies focused primarily on payment mechanisms in the case of safflower seed and evaluate their risk and returns for growers and Mountain States Oilseeds. Development of the empirical model, though applied specifically to raw safflower seed, has important implications for crops that exhibit similar characteristics. Oilseeds like mustard, flax, and sunflowers, among other crops like peas and lentils, also have more significant risks and narrower margins than competing crops and have little access to traditional risk management tools.

The model results indicate that safflower has a relatively high risk compared to other competing crops despite high price expectations in 2022. Numerous variables contribute to the precariousness of the oilseed, but yield, cost, and price risks are significant. Payment structures that employ a fixed or combination lump sum, fixed price can reduce the variability of producer returns by increasing average returns and limiting the effects of lower prices.

It was found that a fixed price performance payment contract most effectively reduced producer risk while minimizing price volatility for Mountain States Oilseeds. The producer-preferred agreement shifts more risk onto the processing firm, ensuring that prices are guaranteed early in the year. For the processor, using a fixed price provides quality adjustments and participation incentives that mitigate the moral hazard, improving MSO's ability to fulfill its processing agreements.

Most importantly, the model supplied evidence that the previous understanding and emphasis on price risk management within safflower contracting does not entirely address the lurking, less apparent sources of return volatility which are cost and yield, especially for varieties cultivated in Utah and Idaho. The aforementioned combination lump sum and fixed price contract offers provocative attestation that both price and yield risks can be managed without undermining the integrity of MSO's risk profile.

Many types of additional provisions could be included in the contract. This study evaluated four pricing formulas and provided a springboard for further investigation into pricing schemes, yield and cost risks, crop insurance, real options, and the implementation of utility functions to more precisely model principal/buyer risk aversion. As there is yet little research in this crop sector, researchers may find this simulated analysis, both its limitations and its conclusions, a beneficial starting point for developing and refining risk management strategies for safflower production in the Intermountain West.

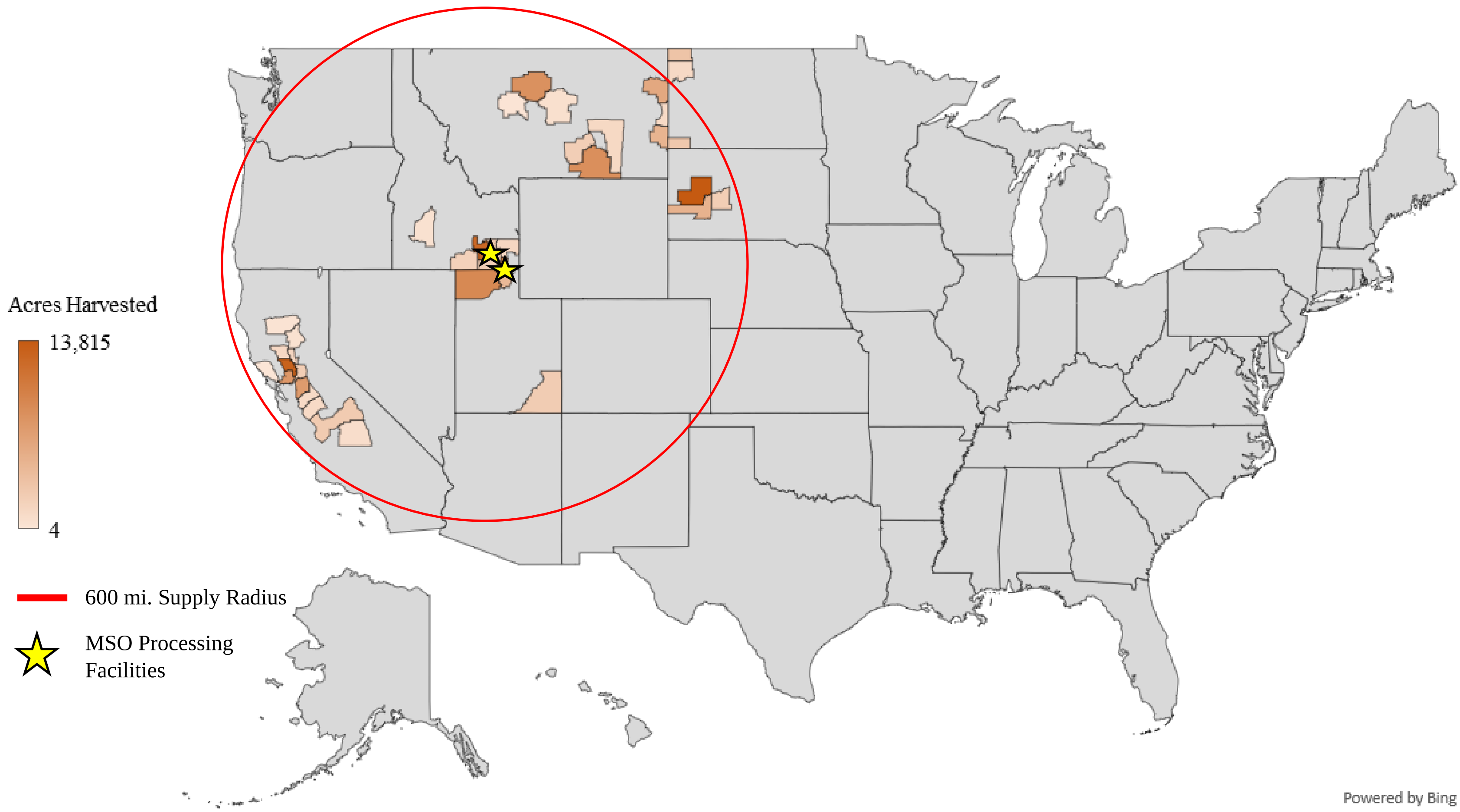
Appendix A

Costs of Non-Irrigated Safflower							
Northern Utah		Quantity per acre	Unit	Price per Unit	Value per Acre	Sub Total	Total
Inputs and Services							
Fertilizer							
	46-0-0 Urea	40	Units	$0.56	$22.40		
	Application	1	Acre	$5.00	$5.00		
Herbicides					$0.00		
	Sonalan (ethalfluralin)	2	Pints	$8.79	$17.58		
	Application	1	Acre	$5.00	$5.00		
Seed		18	Lbs.	$0.34	$6.12		
Labor		1	Acre	$8.56	$8.56		
Crop Insurance (NAP)					$1.25		
Subtotal Inputs and Services						$65.91	
Field Operations		Times	Unit	Per Unit	Acre		
	Fall Chisel Plow	1	Acre	$11.00	$11.00		
	Spring Chisel Plow	1	Acre	$11.00	$11.00		
	Planting	1	Acre	$12.00	$12.00		
	Harvesting	1	Acre	$25.00	$25.00		
	Hauling	1150	Lbs.	$0.01	$11.50		
Subtotal Field Operations Cost						$70.50	
Interest on Operating Capital		Rate	Term	Principle			
		5%	0.5	$132.91		$3.32	
Total Input, Service and Field Operation Costs							$139.73
Overhead							
	Accounting, Liability Insurance, Vehicle Cost, Office Expense				$10.00		
	Cash Lease for Land (includes propery tax)				$35.00		
Total Overhead							$45.00
Total Costs							$184.73

Note: Cost Budget for Non-Irrigated Safflower (Pace et al. 2019). Crop budgets specific to Idaho were not available for safflower so the most recent Northern Utah budget was substituted due to the region's proximity and similarities to Idaho safflower acreage.

Appendix B

Map 1: 2022 Safflower Acres Harvested



Appendix C

Table 6. Producer Discounted Cashflows- Spot Market Scenario

Price Mechanism	Year	Estimated Price ($/ton)	Estimated Yield (tons/acre)	Cost at Time *T* ($/acre)	Cost at Time *T-1* ($/acre)	NPV ($/acre)
Spot Market	2022	$600.00	0.41	$81.96	$102.77	$34.75*

*Note: Price reflects an adjustment for stochastic quality defects at the mean.

Table 7. Producer Discounted Cashflows- Fixed Price Performance Payment Scenario

Price Mechanism	Year	Fixed Price ($/ton)	Estimated Yield (tons/acre)	Cost at Time *T* ($/acre)	Cost at Time *T-1* ($/acre)	NPV ($/acre)
Fixed Price Performance Payment	2022	$600.00	0.41	$81.96	$102.77	$34.75*

*Note: Price reflects an adjustment for stochastic quality defects at the mean.

Table 8. Producer Discounted Cashflows- Indexed Price Performance Payment Scenario

Price Mechanism	Year	Indexed Price ($/ton)	Estimated Yield (tons/acre)	Wheat Price ($/ton)	Cost at Time *T* ($/acre)	Cost at Time *T-1* ($/acre)	NPV ($/acre)
Indexed Price Performance Payment	2022	$623.56	0.41	$236.95	$81.96	$102.77	$43.19*

*Note: Price reflects an adjustment for stochastic quality defects at the mean.

Table 9. Producer Discounted Cashflows- Combo Lump Sum and Fixed Price Payment Scenario

Price Mechanism	Year	Fixed Price ($/ton)	Acreage Pmt. ($/acre)	Estimated Yield (tons/acre)	Cost at Time *T* ($/acre)	Cost at Time *T-1* ($/acre)	NPV ($/acre)
Combo Lump Sum and Fixed Price Payment	2022	$522.67	$24.72	0.41	$81.96	$102.77	$37.97*

*Note: Price reflects an adjustment for stochastic quality defects at the mean.

Appendix D

Table 10. Processor Discounted Cashflows- Spot Market Scenario

Price Mechanism	Year	Price Paid to Producer ($/ton)	Estimated Processing Cost ($/ton)	Estimated Price Received ($/ton)	Expected Revenue ($/ton)	NPV ($/ton)
Spot Market	2022	$582.67*	$250.00	$1,000.00	$167.33	$152.12

*Note: Price reflects an adjustment for stochastic quality defects at the mean.

Table 11. Processor Discounted Cashflows- Fixed Price Performance Payment Scenario

Price Mechanism	Year	Price Paid to Producer ($/ton)	Estimated Processing Cost ($/ton)	Estimated Price Received ($/ton)	Expected Revenue ($/ton)	NPV ($/ton)
Fixed Price Performance Payment	2022	$582.67*	$250.00	$1,000.00	$167.33	$152.12

*Note: Price reflects an adjustment for stochastic quality defects at the mean.

Table 12. Processor Discounted Cashflows- Indexed Price Performance Payment Scenario

Price Mechanism	Year	Price Paid to Producer ($/ton)	Estimated Processing Cost ($/ton)	Estimated Price Received ($/ton)	Expected Revenue ($/ton)	NPV ($/ton)
Indexed Price Performance Payment	2022	$606.22*	$250.00	$1,000.00	$143.78	$130.71

*Note: Price reflects an adjustment for stochastic quality defects at the mean.

Table 13. Processor Discounted Cashflow- Combo Lump Sum and Fixed Price Payment Scenario

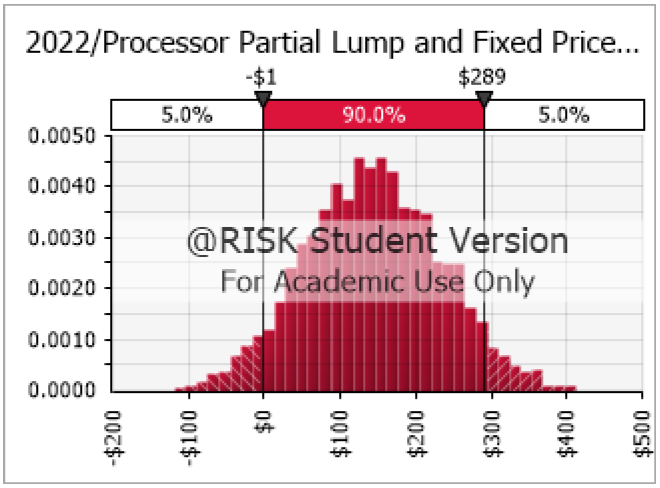
Price Mechanism	Year	Price Paid to Producer ($/ton)	Acreage Pmt. ($/acre)	Estimated Processing Cost ($/ton)	Estimated Price Received ($/ton)	NPV ($/ton)
Combo Lump Sum and Fixed Price Payment	2022	$522.67*	$24.72	$250.00	$1,000.00	$146.67

*Note: Price reflects an adjustment for stochastic quality defects at the mean.

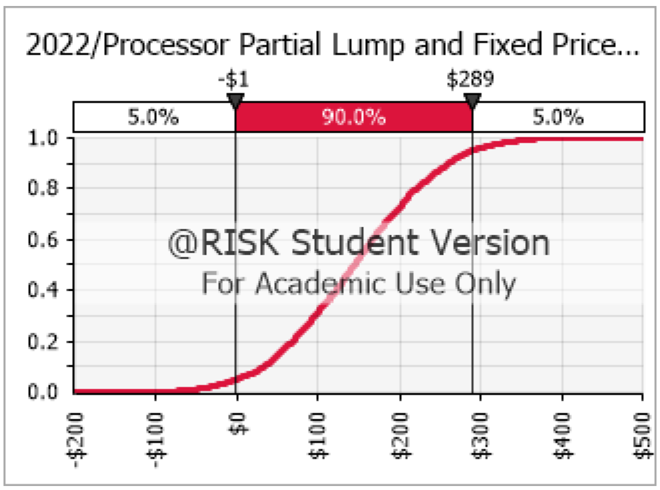
Appendix E

2022/Processor Combo Lump and Fixed Price PMT Expected NPV

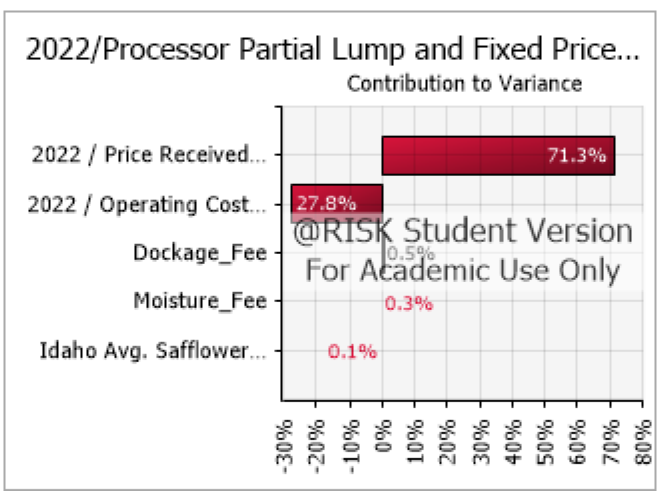
Report: Compact Output Report
Performed By: Jameson Packer
Date: Wednesday, December 14,



Summary Statistics	
Statistic	Value
Minimum	-$118.50
Maximum	$412.53
Mean	$144.19
Std. Deviation	$88.04
Variance	7,751
Skewness	0.0351
Kurtosis	2.7384
Median	$143.75
Mode	$157.94
Left X	-$1.41
Left P	5%
Right X	$289.39
Right P	95%



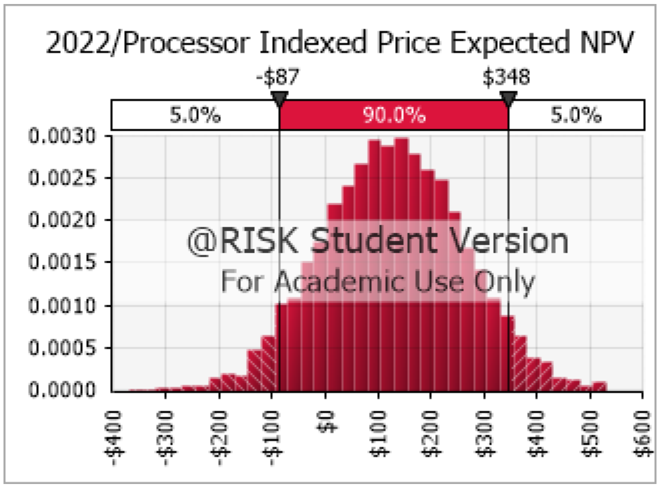
Percentiles	
Percentile	Value
1%	-$54.69
2.5%	-$26.03
5%	-$1.41
10%	$32.39
20%	$68.17
25%	$82.12
50%	$143.75
75%	$205.57
80%	$219.59
90%	$259.49
95%	$289.39
97.5%	$315.78
99%	$347.99



Contribution To Variance		
Rank	Name	Contribution
1	2022 / Price Received for Processed Se...	71.3%
2	2022 / Operating Cost $/Ton	-27.8%
3	Dockage_Fee	0.5%
4	Moisture_Fee	0.3%
5	Idaho Avg. Safflower Yield	-0.1%

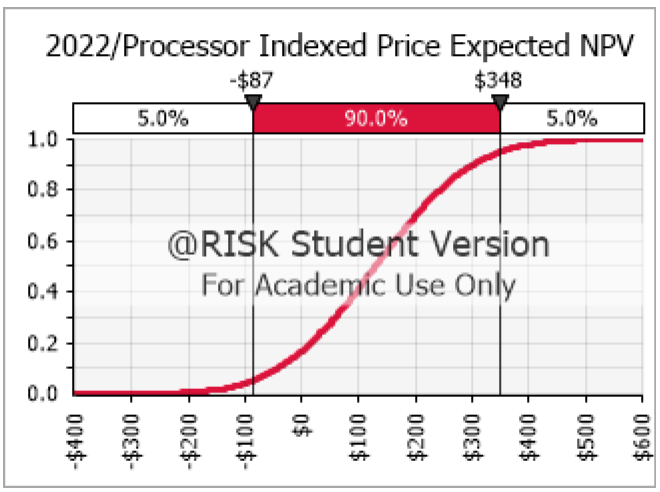
2022/Processor Indexed Price Expected NPV

Report: Compact Output Report
Performed By: Jameson Packer
Date: Wednesday, December 14, 2022



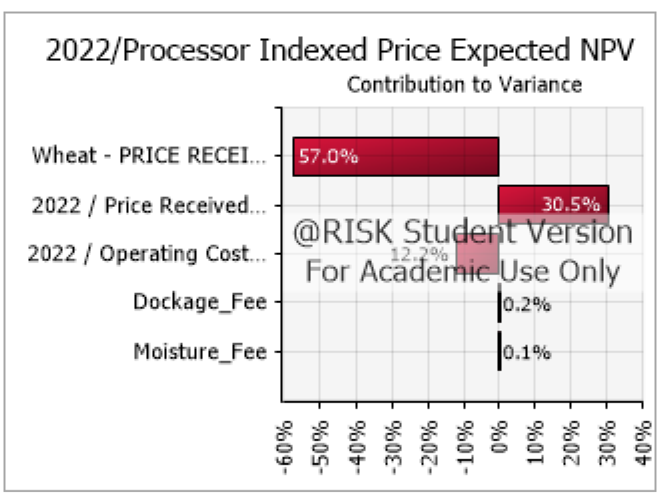
Summary Statistics

Statistic	Value
Minimum	-$369.56
Maximum	$530.86
Mean	$128.50
Std. Deviation	$132.69
Variance	17,605
Skewness	-0.0104
Kurtosis	2.9110
Median	$128.17
Mode	$160.49
Left X	-$87.16
Left P	5%
Right X	$347.79
Right P	95%



Percentiles

Percentile	Value
1%	-$180.66
2.5%	-$124.10
5%	-$87.16
10%	-$42.82
20%	$15.74
25%	$36.90
50%	$128.17
75%	$218.15
80%	$241.48
90%	$301.30
95%	$347.79
97.5%	$388.39
99%	$430.70

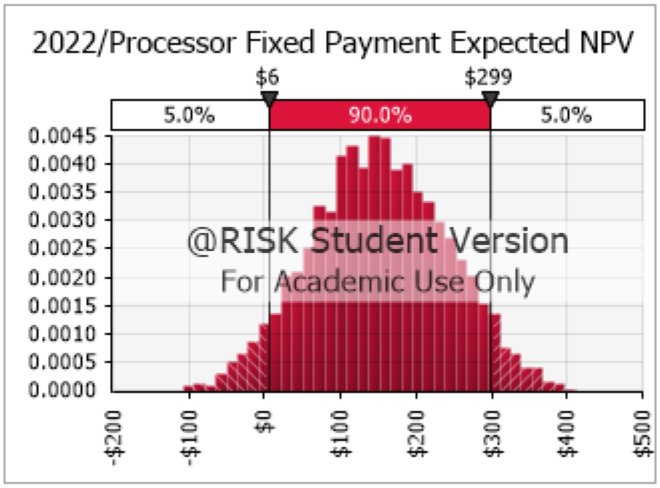


Contribution To Variance

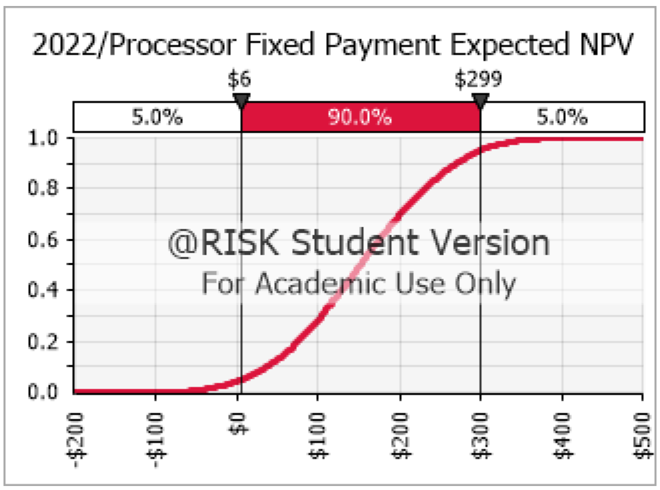
Rank	Name	Contribution
1	Wheat - PRICE RECEIVED- Real $ / Ton	-57.0%
2	2022 / Price Received for Processed Se...	30.5%
3	2022 / Operating Cost $/Ton	-12.2%
4	Dockage_Fee	0.2%
5	Moisture_Fee	0.1%

2022/Processor Fixed Payment Expected NPV

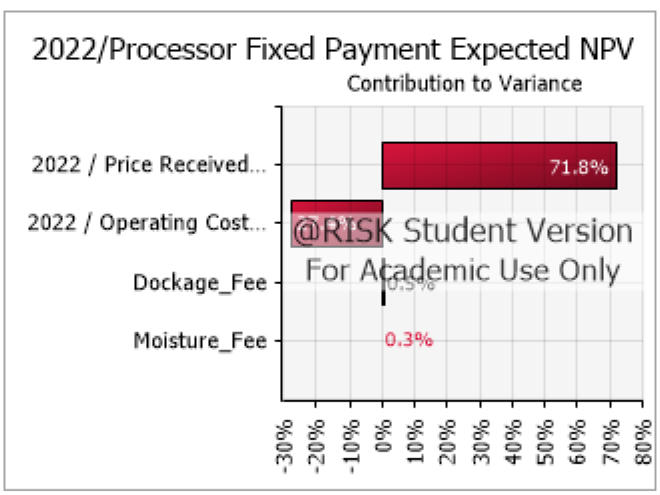
Report: Compact Output Report
Performed By: Jameson Packer
Date: Wednesday, December 14, 2022



Summary Statistics	
Statistic	Value
Minimum	-$107.57
Maximum	$411.51
Mean	$152.12
Std. Deviation	$88.48
Variance	7,828
Skewness	0.0137
Kurtosis	2.6262
Median	$150.99
Mode	$105.27
Left X	$6.00
Left P	5%
Right X	$298.70
Right P	95%



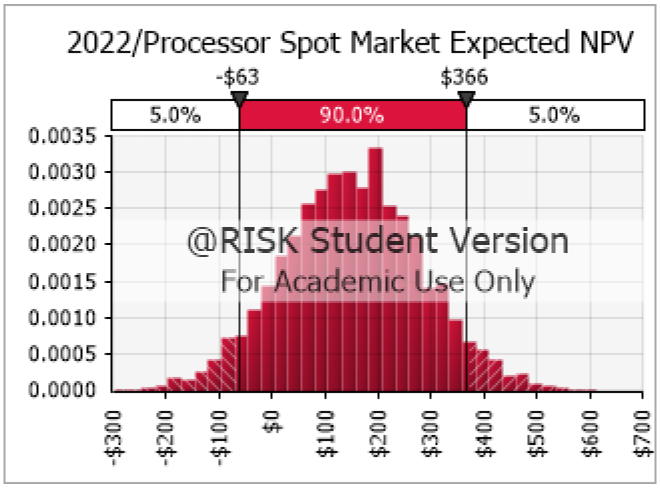
Percentiles	
Percentile	Value
1%	-$43.56
2.5%	-$19.19
5%	$6.00
10%	$36.02
20%	$75.07
25%	$90.49
50%	$150.99
75%	$214.93
80%	$230.04
90%	$270.13
95%	$298.70
97.5%	$322.63
99%	$350.22



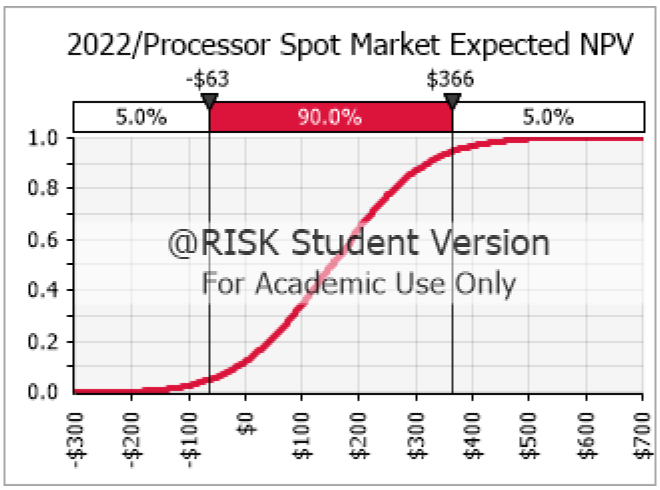
Contribution To Variance		
Rank	Name	Contribution
1	2022 / Price Received for Processed Se...	71.8%
2	2022 / Operating Cost $/Ton	-27.4%
3	Dockage_Fee	0.5%
4	Moisture_Fee	0.3%

2022/Processor Spot Market Expected NPV

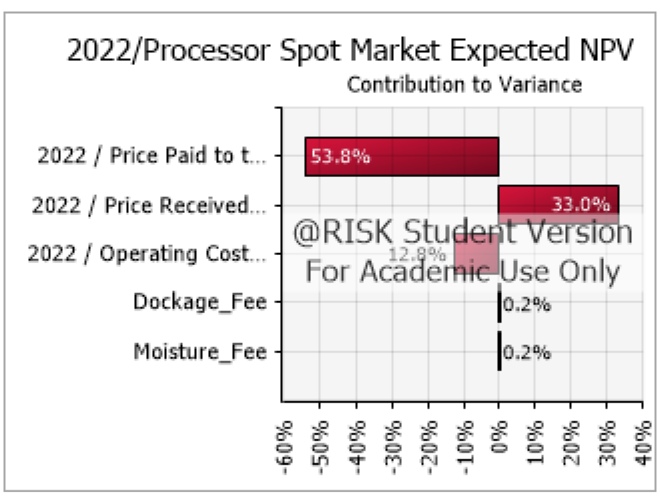
Report: Compact Output Report
Performed By: Jameson Packer
Date: Wednesday, December 14, 2022



Summary Statistics	
Statistic	Value
Minimum	-$297.97
Maximum	$611.95
Mean	$152.12
Std. Deviation	$129.82
Variance	16,854
Skewness	0.0217
Kurtosis	2.9304
Median	$151.71
Mode	$192.59
Left X	-$63.16
Left P	5%
Right X	$365.87
Right P	95%



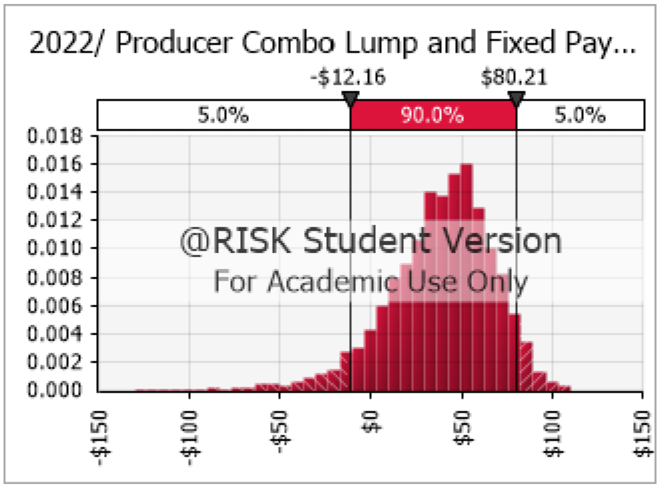
Percentiles	
Percentile	Value
1%	-$149.29
2.5%	-$102.37
5%	-$63.16
10%	-$14.68
20%	$42.67
25%	$64.86
50%	$151.71
75%	$239.43
80%	$260.86
90%	$319.26
95%	$365.87
97.5%	$412.18
99%	$460.78



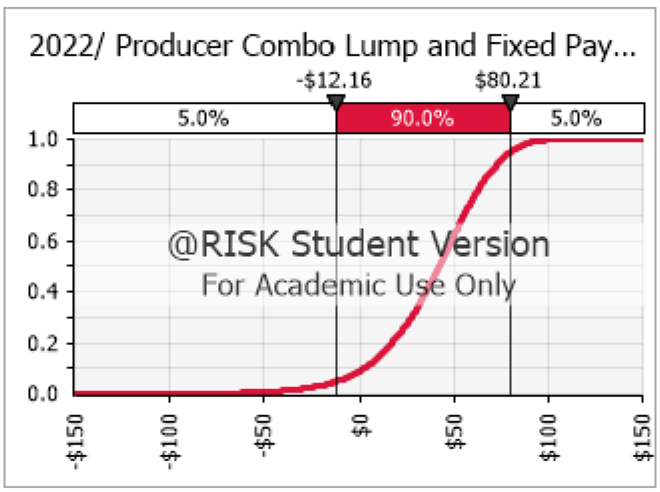
Contribution To Variance		
Rank	Name	Contribution
1	2022 / Price Paid to the Producer $/Ton	-53.8%
2	2022 / Price Received for Processed Se...	33.0%
3	2022 / Operating Cost $/Ton	-12.8%
4	Dockage_Fee	0.2%
5	Moisture_Fee	0.2%

2022/ Producer Combo Lump and Fixed Payment Expected NPV

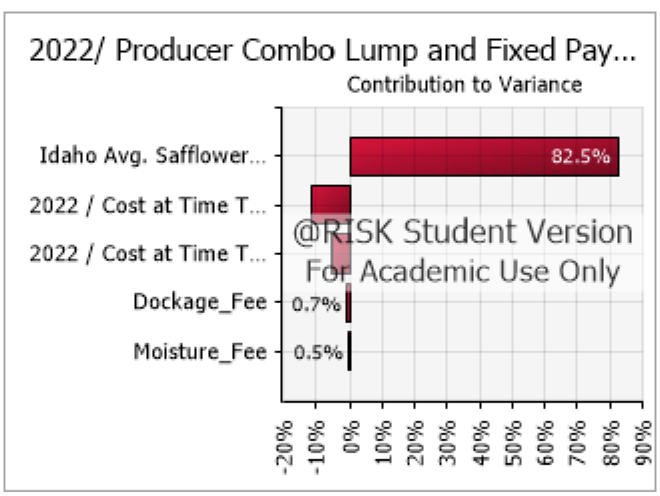
Report: Compact Output Report
Performed By: Jameson Packer
Date: Wednesday, December 14, 2022



Summary Statistics	
Statistic	Value
Minimum	-$129.93
Maximum	$109.62
Mean	$39.07
Std. Deviation	$28.42
Variance	807.8
Skewness	-0.7556
Kurtosis	4.2297
Median	$42.20
Mode	$48.52
Left X	-$12.16
Left P	5%
Right X	$80.21
Right P	95%



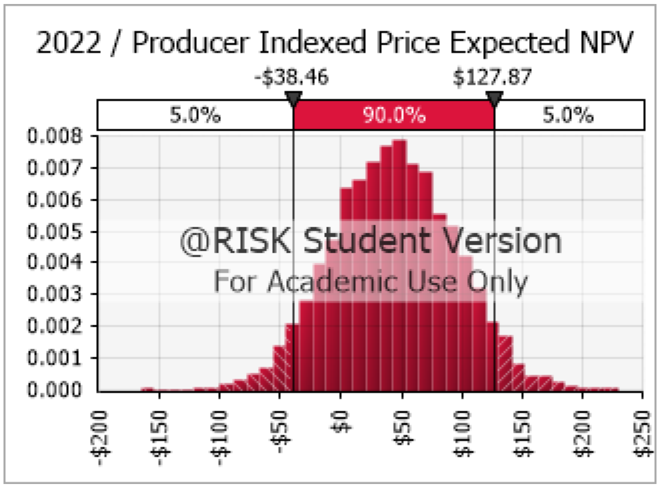
Percentiles	
Percentile	Value
1%	-$44.49
2.5%	-$25.50
5%	-$12.16
10%	$2.24
20%	$16.98
25%	$22.45
50%	$42.20
75%	$58.74
80%	$62.68
90%	$72.94
95%	$80.21
97.5%	$85.66
99%	$91.92



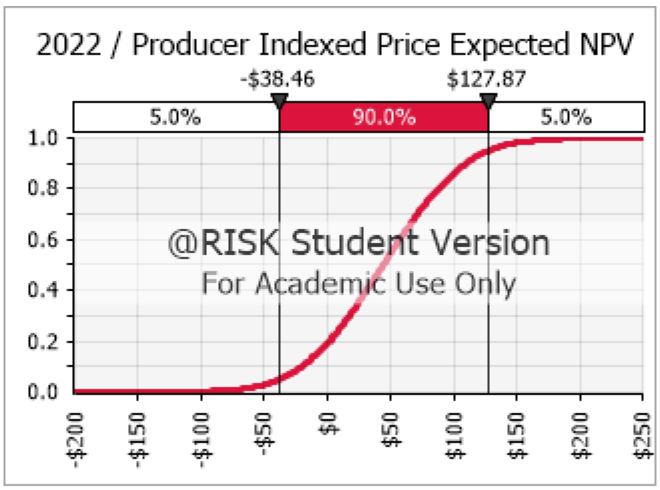
Contribution To Variance		
Rank	Name	Contribution
1	Idaho Avg. Safflower Yield	82.5%
2	2022 / Cost at Time T-1 $/Acre	-11.1%
3	2022 / Cost at Time T $/Acre	-5.1%
4	Dockage_Fee	-0.7%
5	Moisture_Fee	-0.5%

2022 / Producer Indexed Price Expected NPV

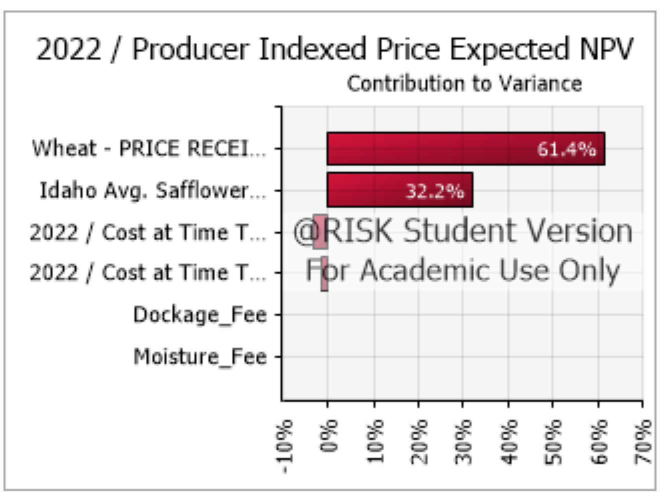
Report: Compact Output Report
Performed By: Jameson Packer
Date: Wednesday, December 14, 2022



Summary Statistics	
Statistic	Value
Minimum	-$165.80
Maximum	$229.53
Mean	$44.13
Std. Deviation	$50.89
Variance	2,589
Skewness	0.0272
Kurtosis	3.0461
Median	$43.48
Mode	$40.47
Left X	-$38.46
Left P	5%
Right X	$127.87
Right P	95%



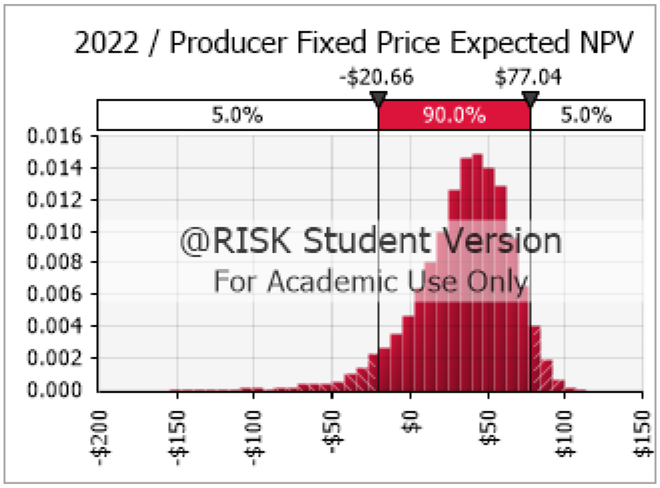
Percentiles	
Percentile	Value
1%	-$72.98
2.5%	-$53.66
5%	-$38.46
10%	-$20.20
20%	$1.13
25%	$8.98
50%	$43.48
75%	$78.66
80%	$87.81
90%	$109.18
95%	$127.87
97.5%	$141.57
99%	$165.45



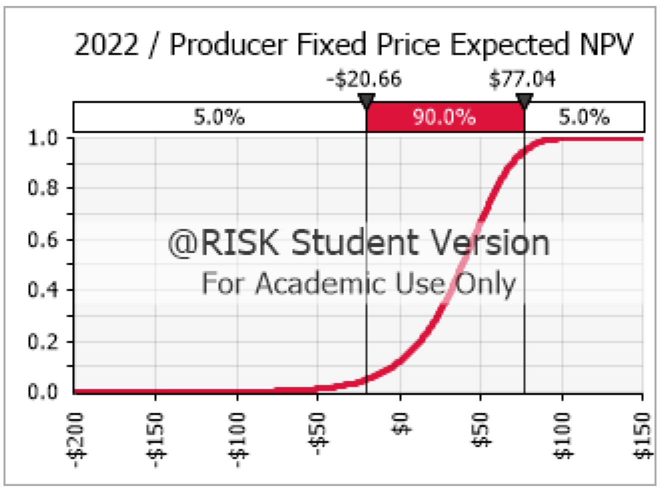
Contribution To Variance		
Rank	Name	Contribution
1	Wheat - PRICE RECEIVED- Real $ / Ton	61.4%
2	Idaho Avg. Safflower Yield	32.2%
3	2022 / Cost at Time T-1 $/Acre	-3.3%
4	2022 / Cost at Time T $/Acre	-1.6%
5	Dockage_Fee	-0.2%
6	Moisture_Fee	-0.2%

2022 / Producer Fixed Price Expected NPV

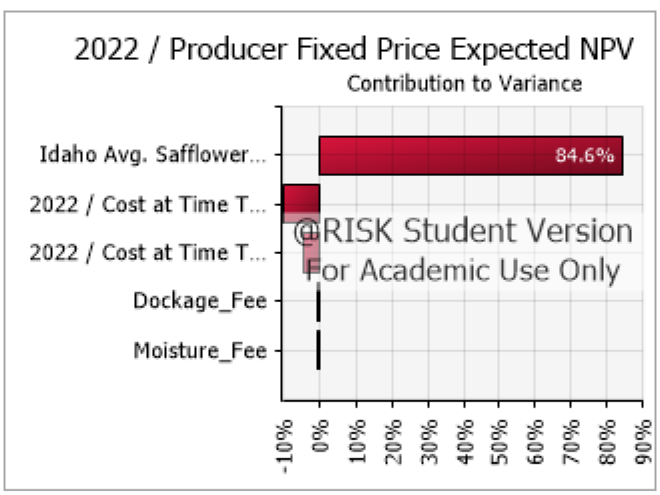
Report: Compact Output Report
Performed By: Jameson Packer
Date: Wednesday, December 14, 2022



Summary Statistics	
Statistic	Value
Minimum	-$154.39
Maximum	$114.31
Mean	$34.75
Std. Deviation	$30.23
Variance	914.0
Skewness	-0.9136
Kurtosis	4.7807
Median	$38.28
Mode	$35.89
Left X	-$20.66
Left P	5%
Right X	$77.04
Right P	95%



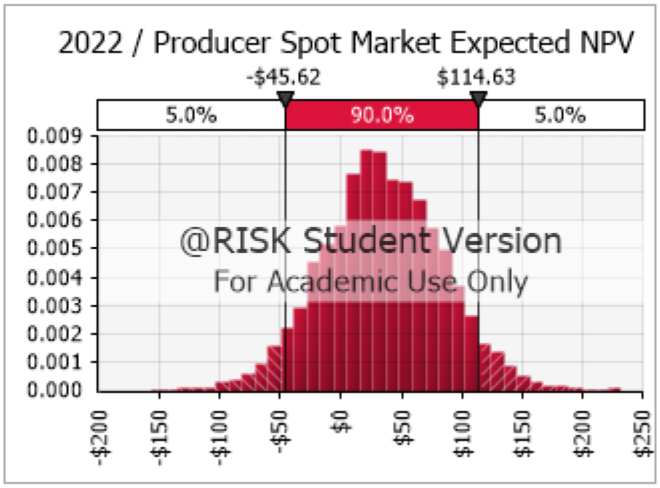
Percentiles	
Percentile	Value
1%	-$58.04
2.5%	-$34.99
5%	-$20.66
10%	-$4.43
20%	$12.68
25%	$18.42
50%	$38.28
75%	$55.80
80%	$59.52
90%	$69.43
95%	$77.04
97.5%	$83.07
99%	$88.98



Contribution To Variance		
Rank	Name	Contribution
1	Idaho Avg. Safflower Yield	84.6%
2	2022 / Cost at Time T-1 $/Acre	-9.9%
3	2022 / Cost at Time T $/Acre	-4.5%
4	Dockage_Fee	-0.6%
5	Moisture_Fee	-0.4%

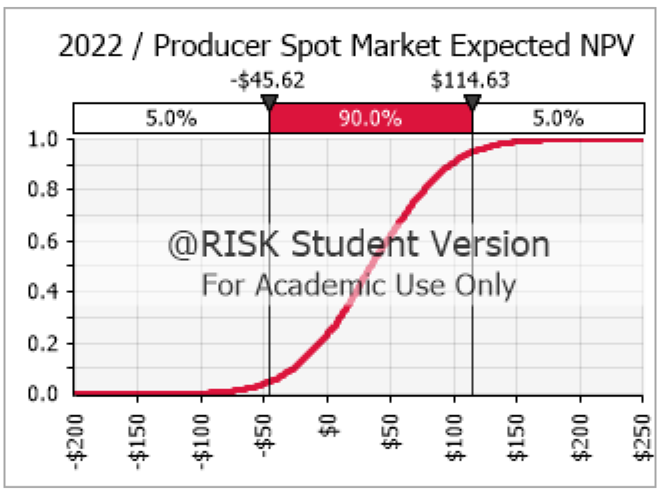
2022 / Producer Spot Market Expected NPV

Report: Compact Output Report
Performed By: Jameson Packer
Date: Wednesday, December 14, 2022



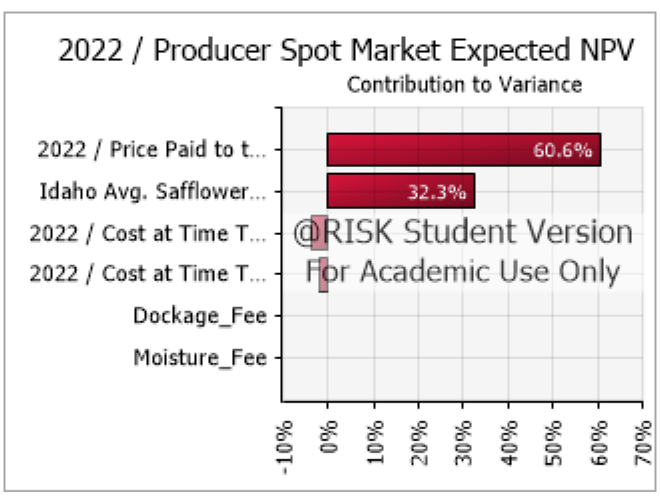
Summary Statistics

Statistic	Value
Minimum	-$157.43
Maximum	$232.25
Mean	$34.78
Std. Deviation	$48.70
Variance	2,372
Skewness	0.0309
Kurtosis	3.0826
Median	$33.90
Mode	$28.32
Left X	-$45.62
Left P	5%
Right X	$114.63
Right P	95%



Percentiles

Percentile	Value
1%	-$79.41
2.5%	-$59.72
5%	-$45.62
10%	-$26.46
20%	-$6.24
25%	$2.61
50%	$33.90
75%	$67.75
80%	$76.18
90%	$97.20
95%	$114.63
97.5%	$131.62
99%	$148.85



Contribution To Variance

Rank	Name	Contribution
1	2022 / Price Paid to the Producer $/Ton	60.6%
2	Idaho Avg. Safflower Yield	32.3%
3	2022 / Cost at Time T-1 $/Acre	-3.8%
4	2022 / Cost at Time T $/Acre	-1.8%
5	Dockage_Fee	-0.2%
6	Moisture_Fee	-0.2%

Mountain States Oilseeds LLC

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American Falls ID 83211
Phone: (208) 226-2041
Fax: (208) 226-9916

Email: monica@msoilseeds.com
www.msoilseeds.com

2022 SAFFLOWER CONTRACT ID UT

This Mountain States Oilseeds LLC Agreement ("Agreement") is executed on this ___day of _______________, the year of 20_____ , by and between Mountain States Oilseeds LLC, 104 Idaho Street Suite B, American Falls, ID 83211, ("MSO"), a limited liability company and Grower (Payee) listed below.

GROWER:		
PAYMENT NAME: (should include Grower & Landlord and/or Lien Holders)	PHONE:	SEED VARIETY:
GROWER NAME:	CELL PHONE:	FAX:
MAILING ADDRESS:	CITY-STATE-ZIP	
PHYSICAL ADDRESS	EMAIL:	

Initial

1. In accordance with this agreement , the Grower shall plant, raise, harvest, and sell and deliver *the entire production* of the crop identified below at the total price identified below minus any deductions allowed under this agreement minus any deductions for freight, checkoff, seed indemnity or other governmentally required payments:

# OF ACRES DRY	# OF ACRES IRRIGATED	FIELD - COUNTY & STATE	FULLY PRICED PRODUCTION/ACRE CLEAN SEED BASIS
			$0.30/LB ($600/ton)

2. TOTAL PRICE: ("Price") in all cases shall include the price identified in paragraph 1 above. MSO may change the number of acres of crop upon notice to grower.

MSO Initial

3. DELIVERY: terms required of Grower:
[ ] HARVEST DELIVERY - safflower shall be delivered to [ ] MSO-Weston [ ] MSO-Am Falls [ ] Other _______________
[ ] FARM-STORED DELIVERY - Grower retains beneficial interest of safflower until MSO calls for delivery. Safflower shall be delivered to:
[ ] MSO-Weston [ ] MSO-Am Falls [ ] Other

4. SUPPLEMENTAL PAYMENTS: At MSO sole-discretion, supplemental payments could be due to the grower. All supplemental payments will be made at the time of settlement.

5. PAYMENT: After grower deliveries are completed and weights and grades are received, MSO shall make payment within 30 days. Costs of grading or testing shall be deducted from the Grower's settlement. In addition, MSO reserves the right to deduct the cost of cleaning the crop to upgrade the crop to acceptable specification.

6. SPECIFICATIONS OR GRADE DEDUCTIONS : Safflower seed shall be storable and millable quality which is determined by the following: seed shall contain a maximum moisture of 8%, must have 5% or less dockage of which only 2% can be other grains, maximum sprout damage of 1%, and a minimum test weight of 38 pounds per bushel. MSO reserves the right to reject or renegotiate the price on safflower if any of the above conditions are not met. In addition, MSO reserves the right to deduct the cost of cleaning safflower which contains an excess of 5% dockage or moisture in excess of 9% as contained in the safflower cleaning charges chart. MSO may accept safflower seed that does not meet specification but the seed will be subject to a price deduction. Moisture over 8% maybe accepted but seed so accepted will be subject to a price deduction as contained in the safflower cleaning charges chart. ZERO TOLERANCE for fertilizer pellets, treated seed, animal filth and glass, if found, crop will be rejected by MSO.

Safflower Cleaning Charges by Short Ton (ST)

Total Dockage - includes other grains and sprout	Cleaning Charge	Moisture	Discount
00.0-5.0% - No charge but all dockage will be deducted from gross inbound weight		8.0-9.0% - No charge but subject to acceptance by MSO	
5.1-6.0%	$8.00 / ST	9.1-10.0%	$6.00 / ST
6.1-10.0%	$10.00 / ST	10.1-11.0%	$12.00 / ST
10.1-12.0%	$12.00 / ST	11.1-12.0%	$18.00 / ST
12.1-15.0%	$15.00 / ST	12.1-13.0%	$24.00 / ST
15.1-17.0%	$18.00 / ST	Any seed in excess of 13% moisture will only be accepted by negotiation.	
17.1-19.0%	$22.00 / ST		
19.1-21.0%	$25.00 / ST		
21.1-22.0%	$28.00 / ST		
All charges are against gross inbound weights.			

Initial

Initial

7. OTHER INTERESTS: Grower shall promptly notify MSO in writing and prior to July 1st of the crop year of the name and address of any person(s) or entity(ies) who may claim an interest in the crop and agrees to hold MSO harmless and indemnify MSO for any act or omission in respect to any such interest not known to MSO. If such interest is already known the grower may enter that on the line below.

CREDITOR OR OTHER INTEREST NAME MAILING ADDRESS PHONE

Grower may assign no rights or obligations without prior written consent of MSO. Subject to the foregoing, this agreement shall insure to the benefit of and bind the successors, assigns, and personal representatives of the parties.

Initial

8. PLANTING SEED: All planting seed for the crop identified above must be obtained from MSO. Grower can request the use of his own common seed with prior approval from MSO. Any seed obtained from an outside source must be inspected by MSO prior to planting. Grower agrees to abide by the Plant Variety Protection Act of 1970. MSO will be held harmless and indemnified including by not limited to any violations, penalties, royalties, or assessments of the Act if caused by any action or inaction of the Grower. Grower agrees to plant all seed obtained, not subletting any portion, separating each variety from any like crop, in a manner approved by MSO.

9. DISCLAIMER of WARRANTY AND LIMITATION OF LIABILITY: MSO may deliver seed, and or provide the process regarding the crop on an "as-is" basis, without warranty of any kind. MSO hereby expressly disclaims all warranties or conditions, either express or implied, including but not limited to, the implied warranties or conditions of merchantability and fitness for a particular purpose and title. The Grower is solely responsible for determining the appropriateness of using the seed and assume all risks associated with the use of the seed. MSO will not be liable for any direct damages, or for any special, incidental, or indirect damages for any economic, consequential damages (including lost profits), even if MSO has been advised of the possibility of such damages. MSO will not be liable for those loss of or damage to, your crops, or land, or and damages claimed by you based on a third-party claim.

PRINT

Initial

2. GROWER CROP PRACTICES AND CROP DAMAGE LIABILITY : Grower agrees to grow for MSO the crop specified in this agreement on clean suitable and proper land. Grower agrees to perform GAP (Good Agricultural Practices). This includes but is not limited to thoroughly cleaning all seed drills, combines, truck beds, storage structures and all other equipment used in planting, growing, harvesting, loading or unloading and storing the crop. Grower agrees to only use labeled and approved chemicals for the crop contracted and take special care when using chemicals on other crops grown adjacent the crop under this agreement.

Grower agrees to at all times prior and during the growing season, harvest season and storage season protect the crop from damage by any foreign contaminant including, but not limited to pests, GMO (genetically modified organism) crops or residue, unapproved or excessive chemical residue or any other matter and to care for, cultivate and harvest in the manner the crop requires to produce perfect merchantable seed. Grower is responsible for notifying MSO of any crop damage immediately and is barred from delivering the crop to any MSO facility. Damaged crop may still be accepted by MSO given prior written approval from an MSO representative. Grower can be held liable for damaging any MSO commodities or property via contamination from Grower delivered crop production.

Initial

3. GMO STATEMENT AND INDEMNIFICATION: Grower understands the importance of keeping all MSO contracted crops free of GMO contamination because MSO must guarantee non-GMO crop status to MSO buyers. Therefore the grower agrees to appropriate multi-year crop rotation practices to protect the crop from other GMO crops, GMO residue, GMO cross-pollination and inseparable seeds. Grower agrees to indemnify and hold harmless MSO from any GMO contamination related issues, problems or claims whether by MSO itself or by any third party. If the grower suspects any potential GMO contamination may have occurred or will occur the grower must contact MSO within 24 hours of discovery and MAY NOT deliver the crop to any MSO facility until further testing, instruction and agreement from MSO. MSO reserves the right to refuse any GMO with actual or suspected GMO contamination. MSO will work with the grower to obtain an appropriate market for the crop if possible at a re-negotiated price to the grower.

4. TRANSFER OF CROP: Upon maturation and at the request of MSO, Grower shall deliver all its production of the crop identified above to MSO. Grower shall not deliver crop from sources other than the Grower's own production of MSO seed. At delivery the Grower warrants and represents that the crop meets all criteria set forth in this agreement. All right, title and interest in and to the crop identified above shall pass from the grower to MSO upon delivery to and acceptance at MSO's designated facility regardless of pricing status. Prior to delivery and acceptance, Grower shall continue to have title and bear all risk of any loss or damage to the crop. All crop delivered by the Grower to MSO shall, at the date and time of delivery, be warranted and represented by the Grower as being transferred as a farm commodity to MSO as a buyer in ordinary course of business, whereby MSO takes such crop free and clear of any liens, claims and interests of the grower and free and clear of any liens, claims and interests of any third-party whether identified below or not.

5. ACCEPTANCE OR REJECTION: At the time or after delivery, MSO may, at its sole option, accept or reject part or all of the crop of a Grower for any reason, including but not limited to the crop's failure to meet the specifications set forth in this agreement. Blending of a rejected crop is not permitted. Inspection of such crop may be taken by MSO or by an independent lab of MSO's choosing. If rejected the Grower agrees to give MSO the first right of refusal regarding purchasing the non-conforming crop at a price negotiated between the Grower and MSO. If the Grower has already been paid, they agree to refund to MSO any monies paid for such rejected crop. In no such case shall the Grower be entitled to any recovery from MSO of any expenses or other claim or indemnity implied or not implied under this Agreement.

Any payment advances issued to Grower will be re-paid 100% to MSO within 10 days a final rejection of the crop. If not repaid within 10 days MSO reserves the right to assess interest on the outstanding funds.

Initial

6. AFTER DELIVERY AND SETTLEMENT: if the Growers crop is identified as not meeting any of the conditions implied or not implied in the agreement the Grower assumes full liability to indemnify and hold harmless MSO from any loss, legal action, claim, or financial responsibility as a result of the Grower's actions.

7. FORCE MAJEURE: Delays in or non-performance of this agreement shall be excused if caused by acts of God, fire, floods, crop failures, frosts, disasters, strikes, lockouts, riots, rebellion, civil commotion, acts of any governmental authority, or events beyond the control of the Grower or MSO.

8. CROP CONSULTING: Grower agrees to allow MSO employees access to the land on which the crop is grown and to do a visual inspection of any farm storage facilities at any time. MSO will be held harmless from any and all crop recommendations given about the growing, harvesting or storing of any crop identified under

9. GROWER DEFAULTS: MSO has all rights and remedies available at law, including, but not limited to the right to harvest and remove the crop, the right to an injunction to prevent furtherance of such breach and the right to specific performance of his contract, and shall be entitled to charge to grower all costs of exercising such rights and remedies, including legal costs in full indemnity basis as between a solicitor and such solicitor's own client.

10. DEATH OR DISABILITY: In the event of death or disability of the Grower, or upon the happening of an event that prevents the Grower from continuing to take the actions necessary to care for the crop identified above, MSO is granted the right to enter the premises of the Grower and complete the growing harvest and delivery of the crop to MSO. Grower hereby releases MSO from any liability of any kind or nature for any actions undertaken by MSO under such circumstances. Otherwise all other provisions of the Agreement shall apply to the crop and parties.

11. TERMINATION: This Agreement is effective as of the date of the Agreement and cannot be terminated unless agreed to in writing by both MSO and the Grower.

12. GOVERNING LAW: This agreement constitutes the entire agreement between the parties and can only be amended by a written document signed by both parties to this agreement. This agreement cannot be assigned by either party without the other parties' written consent and is binding on the heirs and successors and assigns of those parties. This agreement is governed by Idaho law in the event of any litigation or arbitration regarding this agreement such litigation or arbitration can be brought in Power County, Idaho. Both parties agree that they hereby waive any right to litigation, in the event of any disagreement regarding the terms and conditions of this agreement; Instead, both parties agree that they shall be bound by the by laws and regulations of the American Arbitration Association, it being the desire an intent of the parties to submit any and all matters involving this agreement to binding arbitration rather than litigation. BOTH PARTIES TO THIS AGREEMENT WAIVE ANY RIGHT TO A TRIAL BY JURY.

THIS AGREEMENT AND PRICE WILL NOT BE CONSIDERED VALID UNTIL SIGNED BY MSO AND GROWER. BY SIGNING THIS AGREEMENT, THE GROWER ACKNOWLEDGES THAT IT HAS BEEN READ ENTIRELY AND IS UNDERSTOOD AND BINDING.

CONTRACT PRICE OFFERED WILL REMAIN VALID UNTIL ____________________.

GROWER ACCEPTANCE	DATE	MOUNTAIN STATES OILSEEDS LLC	DATE
SIGN	PRINT	SIGN	

References

Allen, D., D. Lueck. “Risk Preferences and the Economics of Contracts,” *The American Economic Review* Volume 85, No. 2:447-451. https://www.jstor.org/stable /2117964#metadata_info_tab_contents

Allen, D., D. Lueck. “The Role of Risk in Contract Choice,” *Journal of Law, Economics and Organization* Volume 15, No. 3:704-736. https://www.jstor.org/stable /3555088#metadata_info_tab_contents

Arouna, A., J. Michler, and J. Lokossou. “Contract farming and rural transformation: Evidence from a field experiment in Benin,” *The Journal of Development Economics* Volume 151. https://doi.org/10.1016/j.jdeveco.2021.102626.

Bergman, J., and H. Kandel. 2019. *Safflower Production*, revised. Fargo ND: NDSU Extension. https://www.ndsu.edu/agriculture/sites/default/files/2021-05/a870.pdf

Besanko, D., D. Dranove, M. Shanley, and S. Schaefer. *Economics of Strategy*. Hoboken, New Jersey: Wiley Custom, 2017.

Casaburi, L., M. Kremer, S. Mullainathan, and R. Ramrattan. “Contract Farming, Technology Adoption and Agricultural Productivity: Evidence from Small Scale Farmers in Western Kenya,” *Harvard University* (2014). https://arefiles.ucdavis.edu/uploads/filer_public/2014/03/27 /casaburi_et_al_ict_agriculture_20140306.pdf

CFI Team. “Spot Market.” Last Modified October 24, 2022. https://corporatefinanceinstitute.com/resources/wealth-management/spot-market/

China Prairie. *Safflower Power! Seed Treat 1 lb.* Retrieved November 20, 2022. https://www.chinaprairie.com/Merchant2/merchant.mvc?Screen=PROD&Product_Code=SAFF1 LB.

Food and Agricultural Organization of the United Nations. *Crops and Livestock Products: Import Quantity/Export Quantity*. Rome, Italy: FAO, 2020. https://www.fao.org/faostat/en/#data/TCL

Food and Agricultural Organization of the United Nations. *Crops and Livestock Products: Production Quantity/Production Value*. Rome, Italy: FAO, 2020. https://www.fao.org/faostat/en/#data/TCL

Godfrey, J. 2022. (Owner and full partner, Mountain States Oilseeds), in discussion with the author. April.

Grains Research and Development Corporation. *GrowNotes: Safflowers*. Barton, Australian Capital Territory: Grains Research and Development Corporation, 2017.

Hamilton, Neil. *Farmer's Legal Guide to Production Contracts.* Fayetteville: University of Arkansas, 1995.

Kaffka, S., T. Kearney. *Safflower Production in California*. Oakland, CA: University of California, Division of Agriculture and Natural Resources, 1998.

MacDonald, J., J. Perry, M. Ahearn, D. Banker, W. Chambers, C. Dimitri, N. Key, K. Nelson, and L. Southard. *Contracts, Markets, and Prices: Organizing the Production and Use of Agricultural Commodities.* Washington, DC: ERS, 2004. https://ageconsearch.umn.edu /record/34013?ln=en

Mordor Intelligence. 2021. *Safflower Seeds Market- Growth, Trends, COVID-19 Impact, and Forecasts (2022-2027).* Hyderabad, Telangana, India: Mordor Intelligence.

Mountain States Oilseeds. n.d. "Our History." Accessed June 28, 2022. https://www.msoilseeds.com /mso-company-history

Outlaw, J., L. Ribera, J. Richardson, J. da Silva, H. Bryant, and S. Klose. "Economics of Sugar-Based Ethanol Production and Related Policy Issues," *Journal of Agriculture and Applied Economics* Volume 39, No. 2:357-363.

Pace, M., and Creech, E. *Growing Safflower in Utah.* Logan, UT: USU Extension, 2015. https://extension.usu.edu/crops/research/safflower-in-utah#:~:text=In%20Northern%20Utah%2C%20the%20plants,time%20period%20(Figure%205).

Pace, M., C. Israelson, E. Creech, and N. Allen. 2015. *Growing Safflower in Utah*. Logan UT: USU Extension. https://aes.colostate.edu/swrcr/wp-content/uploads/sites/92/2019/03 /GrowingSafflowerinUtah.pdf

Pace, M., C. Israelson, R. Larsen, and J. Hadfield. 2019. *Costs and Returns for Non-Irrigated Safflower, Northern Utah.* Logan UT: USU Extension. https://digitalcommons.usu.edu/cgi /viewcontent.cgi?article=3081&context=extension_curall

Reutlinger, S. "Techniques for Project Appraisal under Uncertainty," *World Bank Staff Occasional Papers* Number 10.

Richardson, J., and Mapp, H. "Use of Probabilistic Cashflows in Analyzing Investments Under Conditions of Risk and Uncertainty," *Southern Journal of Agricultural Economics* No. 8:19-24.

Selina Wamucii. 2022a "Ukraine Safflower Market Insights." Accessed October 4, 2022. https://www.selinawamucii.com/insights/market/ukraine/safflower/#:~:text=safflower%20in%20 2019.-,Production,215.00%20hectares%20under%20safflower%20cultivation.

Selina Wamucii. 2022b "Russia Safflower Market Insights." Accessed October 4, 2022. https://www.selinawamucii.com/insights/market/russia/safflower/

Smith, J., and Jimmerson, V. "Safflower Oil." In *Bailey's Industrial Oils and Fat Products,* edited by Fereidoon Shahidi and Chi-Tang Ho. Hoboken, NJ: Wiley Custom, 2005.

Stigler, G., and Becker, G. "De Gustibus Non Est Disputandum," *The American Economics Review* Volume 67, No. 1:76-90.

Unknown. *Contact MSO.* Retrieved November 20, 2022. https://www.msoilseeds.com/explanation-of-how-to-contact-mso

U.S. Census Bureau: National Agriculture Statistics Service. *Agriculture Census of Farm Producers.* Washington, DC: NASS Census of Agriculture, 2017. https://www.nass.usda.gov /Publications/Highlights/2019/2017Census_Farm_Producers.pdf

U.S. Department of Agriculture, National Agriculture Statistics Service. *Quickstats: Acreage Harvested, Price Received, Production, Yield.* Washington, DC: NASS, 2021. https://quickstats.nass.usda.gov/

U.S. Department of Agriculture. 2016. *A Crop Profile for Safflower Production in California*. Raleigh NC: Integrated Pest Management, March. https://ipmdata.ipmcenters.org/documents /cropprofiles/Safflower Crop Profile 3-1-2016 MB.pdf

U.S. Department of Agriculture. 2022a. *2021 State Agriculture Overview-Idaho.* Washington DC: National Agriculture Statistics Service, October. https://www.nass.usda.gov/Quick_Stats /Ag_Overview/stateOverview.php?state=IDAHO

U.S. Department of Agriculture. 2022b. *The Ukraine Conflict and Other Factors Contributing to High Commodity Prices and Food Insecurity.* Washington DC: Foreign Agricultural Service, April. https://www.fas.usda.gov/sites/default/files/2022-04/22%2004%2006%20Food%20Prices %20and %20Food%20Security_1.pdf

Vassalos, M., H. Wuyang, T. Woods, J. Schieffer, and C. Dillon. "Risk Preferences, Transaction Costs, and Choice of Marketing Contracts: Evidence from a Choice Experiment with Fresh Vegetable Producers," *Agribusiness* Volume 32: 379-396. https://onlinelibrary.wiley.com /doi/10.1002/agr.21450

Vavra, P. "Role, Usage and Motivation for Contracting in Agriculture," *OECD Food, Agriculture and Fisheries Papers* Volume 16. https://www.oecd-ilibrary.org/content /paper/225036745705

Wilson, W., and Dahl, B. "Grain Contracting Strategies: The Case of Durum Wheat," *Agribusiness* Volume 27, 55120. https://www.researchgate.net/publication /46472822_Grain_Contracting_Strategies_The_Case_of_Durum_Wheat

Wilson, W., and Dahl, B. "Contracting for Canola in the Great Plains States," *Canadian Journal of Agricultural Economics* Volume 62:89-106. https://onlinelibrary.wiley.com/doi/full /10.1111/cjag.12017

Yeboah, A., C. Naanwaab, O. Yeboah, J. Owens, and J. Bynum. "Economic Feasibility of Sustainable High Oilseed-Based Biofuel Production: The Case for Biodiesel in North Carolina," *International Food and Agribusiness Management Review* Volume 16, No. 1:41-66. https://www.ifama.org/resources/Documents/v16i1/Yeboah-Naanwaab-Yeboah-Owens-Bynum.pdf

Yesilyurt, M., C. Cesur, V. Aslan, and Z. Yilbasi. "The production of biodiesel from safflower (Carthamus tinctorius L.) oil as a potential feedstock and its usage in compression ignition engine: A comprehensive review," *Renewable and Sustainable Energies Review* 119, no. 3 (2020): 109574, https://www.sciencedirect.com/science/article/pii /S1364032119307828?via%3Dihub