COST - BENEFIT ANALYSIS OF DIRECT SEEDING

Direct seeding and conservation agriculture are promising agricultural practices that offer significant economic and environmental benefits for soybean and maize farmers. The cost-benefit analysis from AKTC in Zambia shows that these practices are more profitable and sustainable compared to conventional tillage methods.

Background

In the face of fluctuating weather patterns and rising input costs, farmers are increasingly seeking sustainable and cost-effective agricultural practices. Direct seeding and conservation agriculture (CA) potentially enhance productivity while reducing operational costs. But it is commonly known that the agronomic and economic benefits of CA only occur in the long term, because the biological, chemical, and physical properties of the soil improve gradually, and it may take up to a decade before yield increases.

However, short-term effects are still important from the farmers' perspective. The first years play a crucial role in determining whether farmers, who often have short-term needs and trade-offs, will or will not continue to practice CA. When demonstrating the conditions under which switching to mechanized CA practice does not negatively affect the economy in the early years, a major barrier to CA adoption is tackled.

The Agriculture Knowledge and Training Centre (AKTC) in Zambia assessed the costs and benefits of mechanised CA for a farmer cultivating maize and soybean that hires agricultural machinery services for three different mechanised treatments – namely disc harrowing, ripping and direct seeding.

Cost Calculation

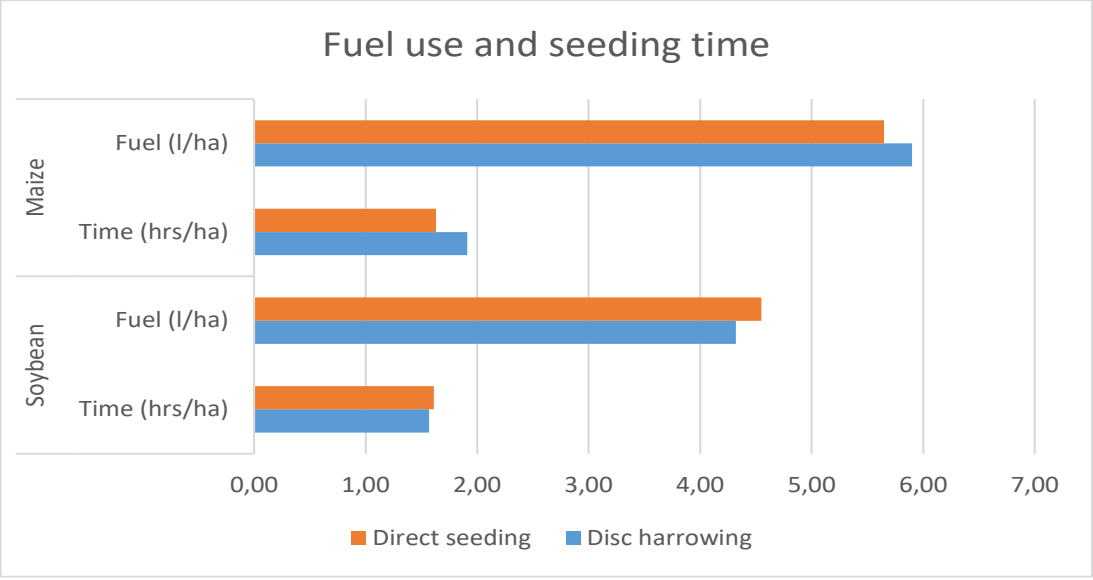
The objective was to evaluate and compare the potential net benefits of using conventional tillage and CA systems for soybean and maize. For five seasons and each plot per crop, the total variable cost was estimated by factoring in machinery and labour hiring charges and all input costs for seeds, fertilisers, herbicides, pesticides,

and fungicides. Throughout the cultivation period, time records during land preparation, tillage, planting, fertilisation, herbicide application, fungicide, pesticide application, harvesting, shelling, transport and bagging were kept for hiring charges and machinery operation for each of the three treatments and per crop. The total revenue was determined from yield measured in and the national grain prices. Total revenue earned from the two crops was calculated based on the unit buying price per kilogramme of grain according to the Zambian Government rates and the crops yield in the respective seasons.

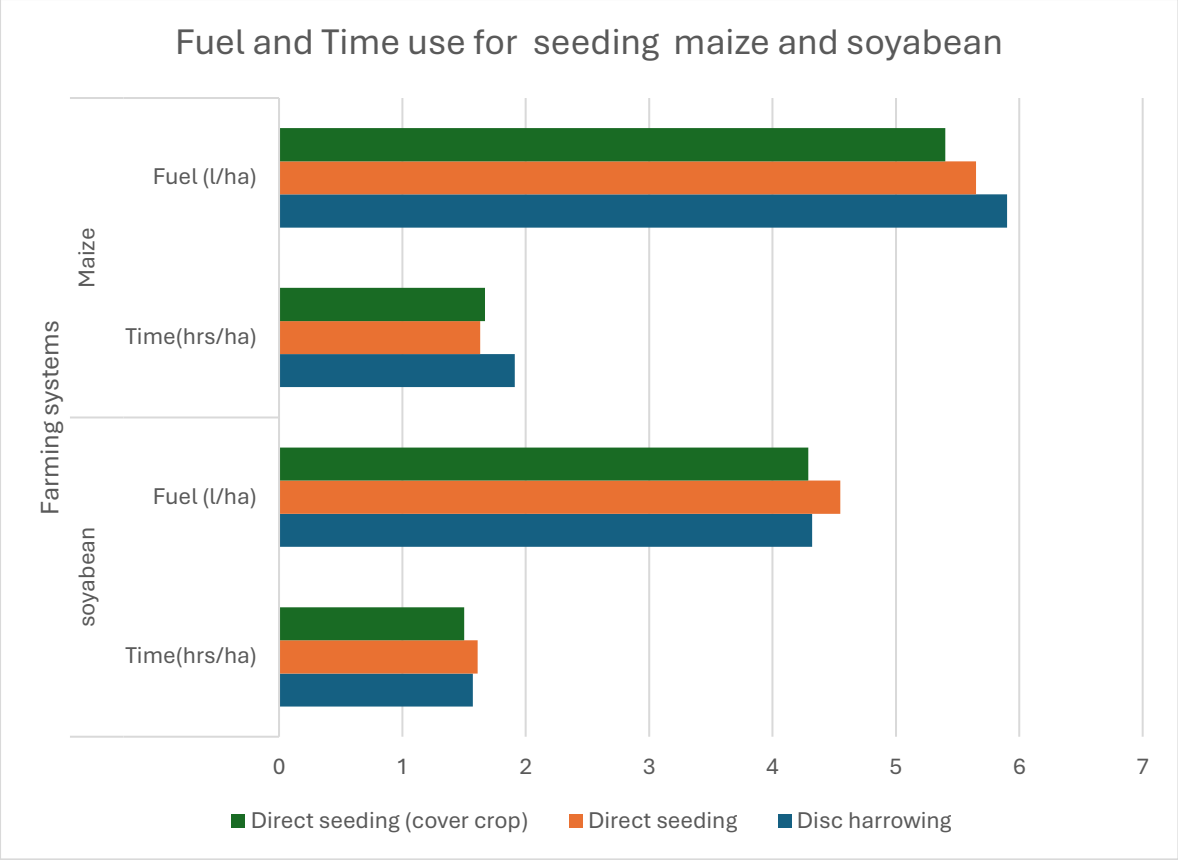
To calculate the costs for the economic analysis, imputed values for hired machinery were used. In addition, actual operation time and fuel use was measured. These findings are relevant as time and labour constraints continue to limit agricultural productivity among small and medium-scale farmers.

Fuel Use and Operations

One of the significant advantages of direct seeding is the reduction in fuel and time required for land preparation. Disc-harrowing was the only operation that consumed time and fuel during land preparation. In contrast, both direct seeding and cover crop rotation plots required no tillage before planting, resulting in zero time and fuel consumption. This benefit significantly reduces operational costs for farmers adopting direct seeding in cover crops, maize, and soybean crop residues. The figure compares the fuel use and seeding time among different farming systems.



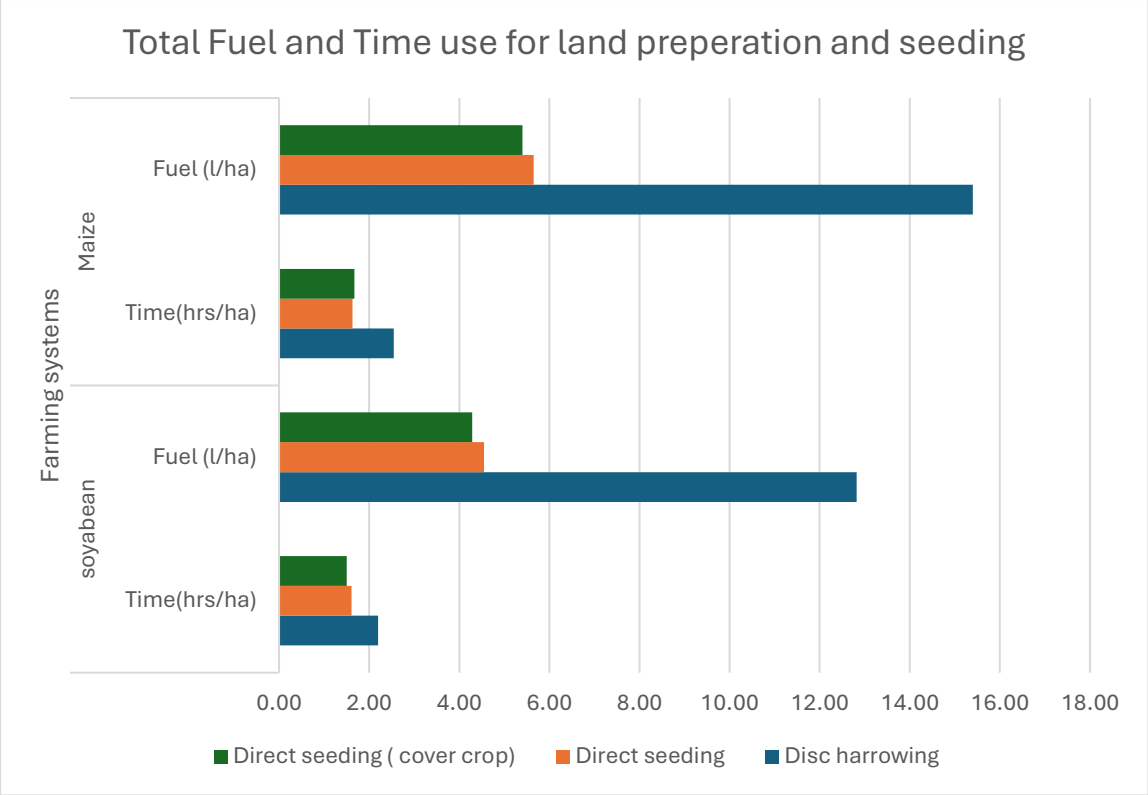
Source: AKTC, CAFM project season 2023/2024



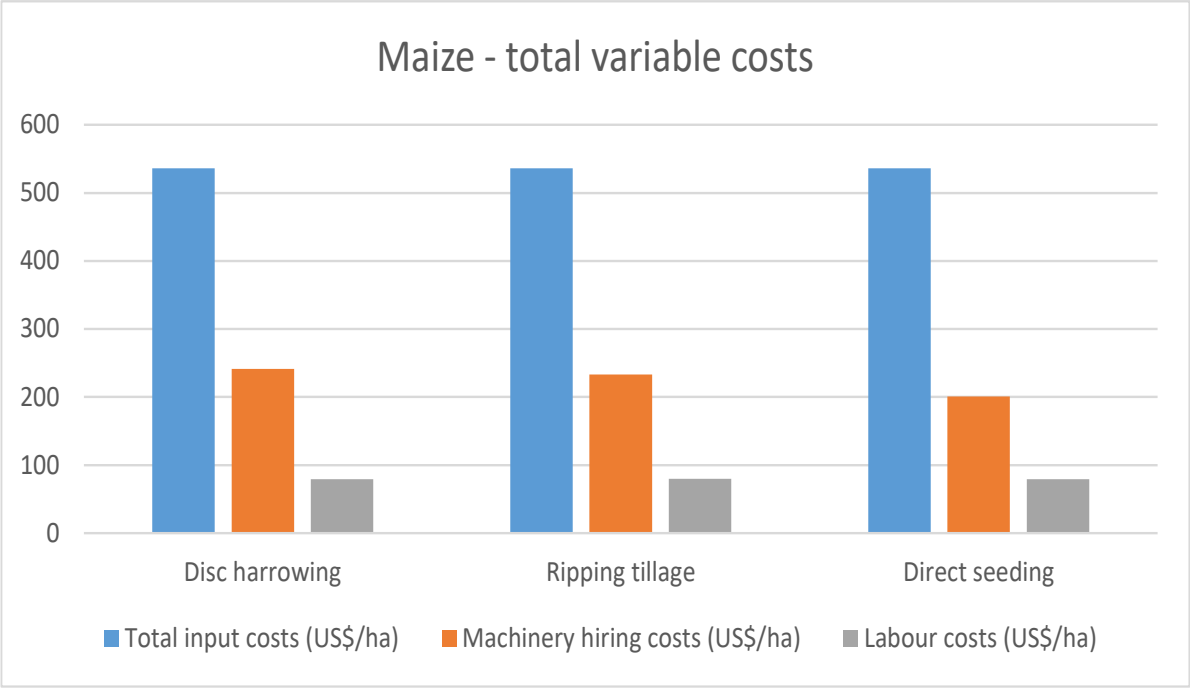
Source: AKTC, CAFM project season 2023/2024

Seeding soybeans directly into maize crop residues takes more time (1.61 hours per hectare) and uses more fuel (4.55 liters per hectare). This is because the dry and thick maize residues reduce seeding efficiency. In contrast, seeding maize in plots with cover crops uses the least fuel (5.4 liters per hectare). This demonstrates the efficiency of cover crops in improving seeding operations.

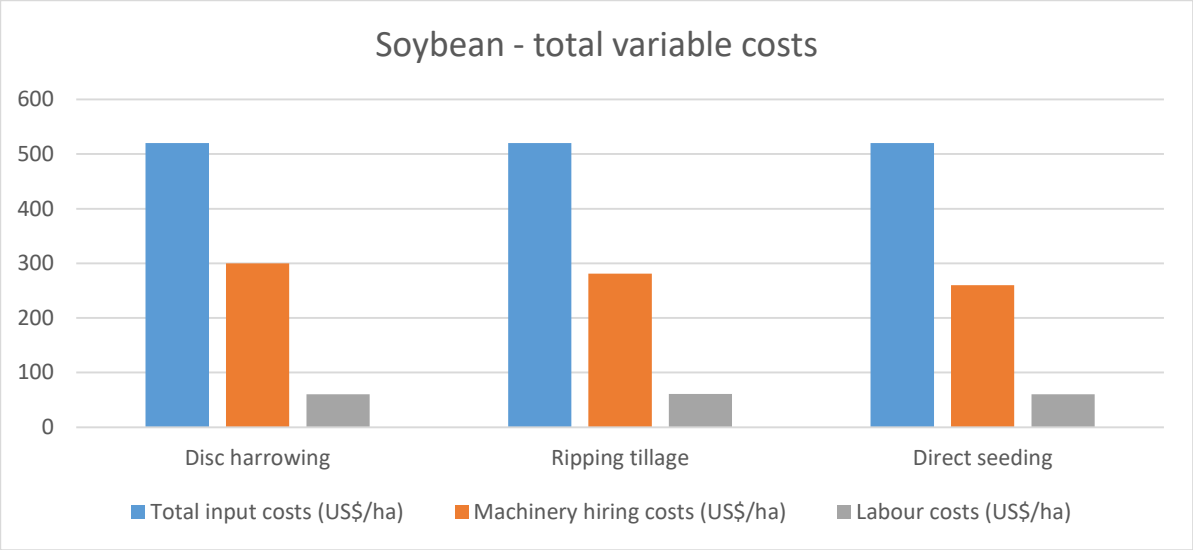
Table below indicates the significancy of direct sowing of maize and soyabean crops with regard to time and fuel use during land preparation and seeding. Disc harrowing more total time for land preparation and seeding than average direct seeding by 29.0 % and 35.3% for soyabean and maize crops. Similarly total fuel usage was much higher under disc harrowing than average direct seeding of soyabeans by 65.5 % and direct seeding of maize 64.1 %.



Source: AKTC, CAFM project season 2023/2024



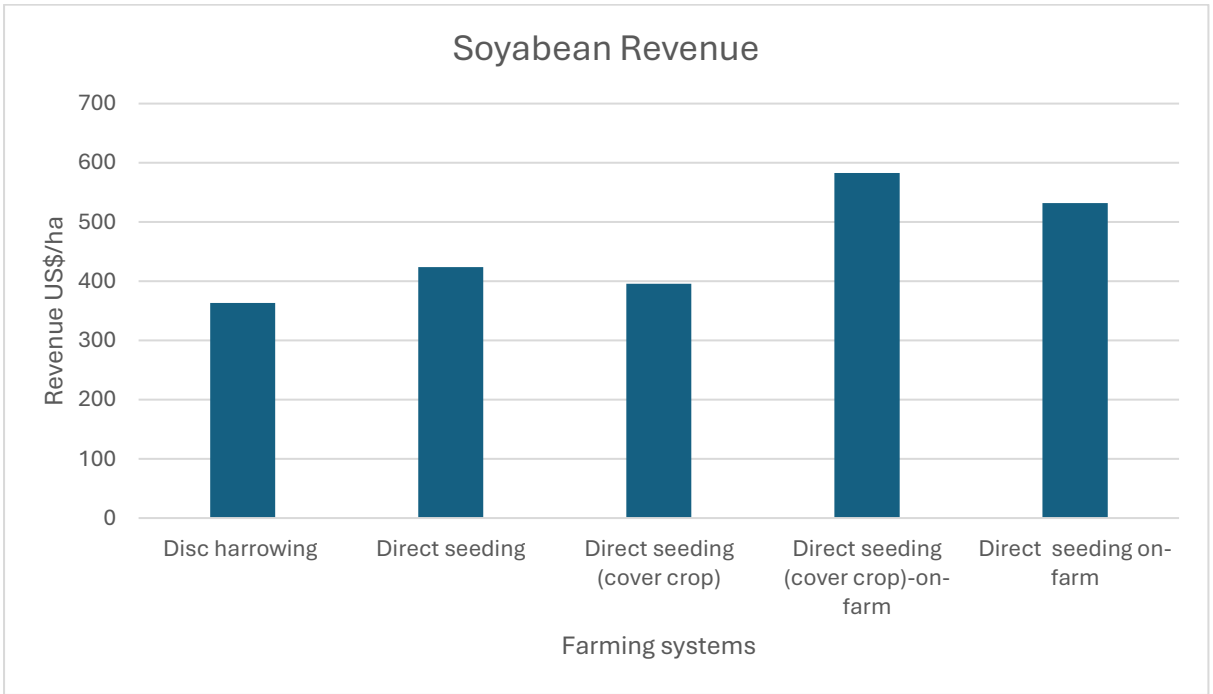
Source: Godfrey 2022



Source: Godfrey 2022

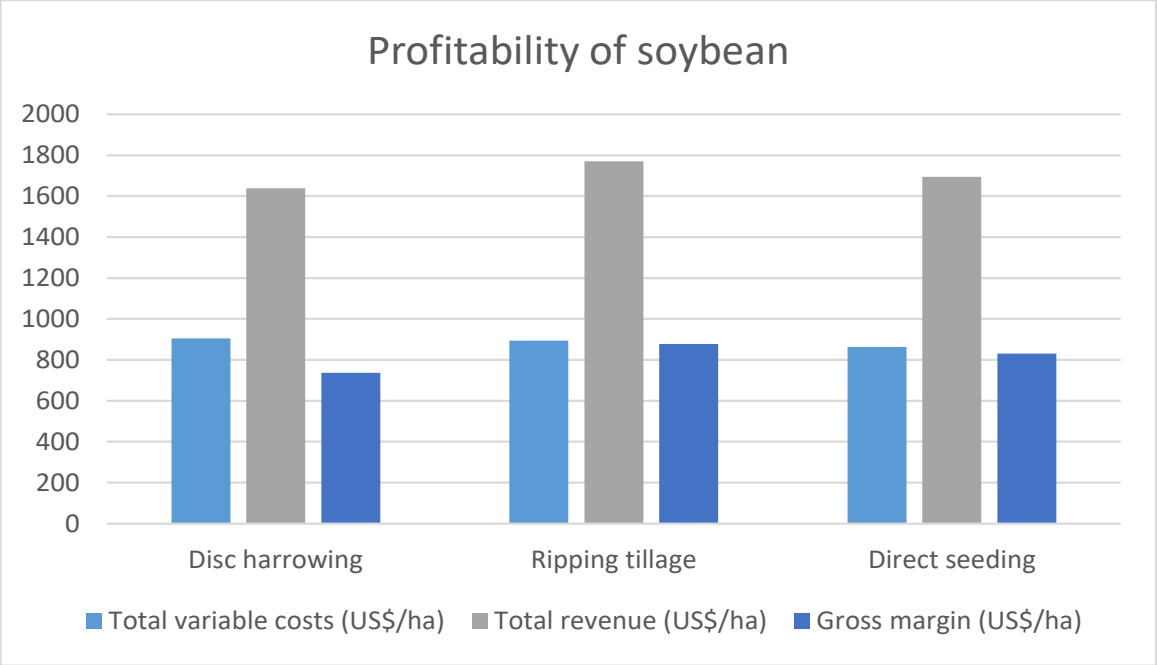
Soybean Economic Analysis

Soybean crops grown in disc harrowed plots had the lowest revenue, amounting to 363.42 USD per hectare. In contrast, direct seeding and cover crop plots at the research station recorded revenues that were 11.3% higher. Moreover, on-farm trials indicated that cover crop and direct seeding plots achieved revenues 37.6% and 31.7% higher than disc harrowed plots, respectively.



Source: AKTC, CAFM project season 2023/2024

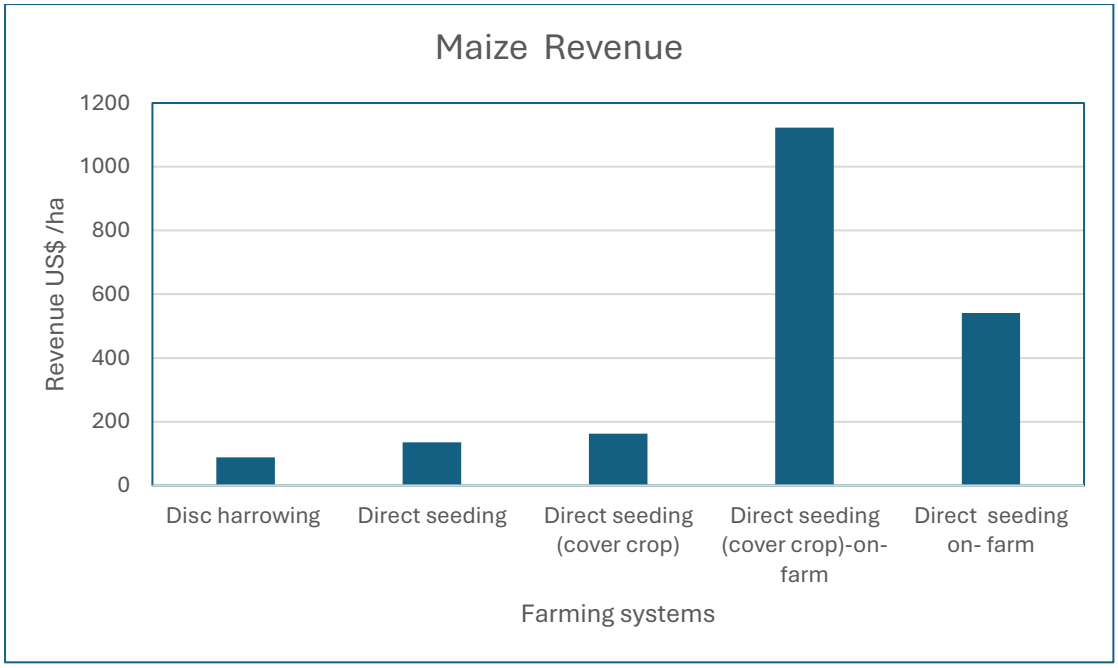
In terms of costs, soybean production expenses were generally high, with the highest being 844.07 USD per hectare in disc harrowed plots. However, the increased yields and revenues from cover crops and direct seeding plots offset these costs, resulting in better economic returns. Despite this, all soybean farming systems showed losses when comparing returns to total variable costs. The highest loss was 56.94% in disc harrowed plots, while the smallest loss was 10.44% in direct seeding plots from on-farm trials.



Source: Godfrey 2022

Maize Economic Analysis

Regarding maize production, maize crops grown in disc harrowed plots generated the lowest revenue, totalling 88.1 USD per hectare. On the other hand, cover crop and direct seeding plots recorded significantly higher revenues. On-farm trials demonstrated that cover crop and direct seeding plots produced revenues 92.2% and 83.7% higher than disc harrowed plots, respectively.



Source: AKTC, CAFM project season 2023/2024

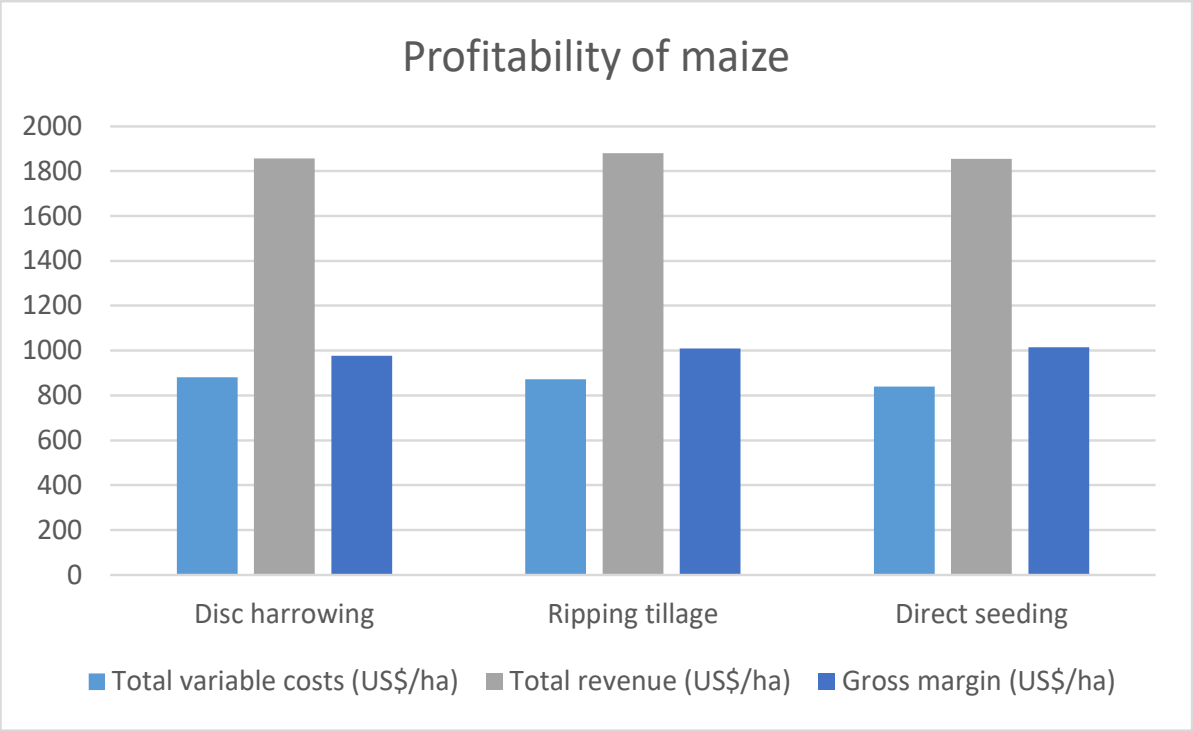
Source: Godfrey 2022

The cost analysis for maize revealed that the highest costs were associated with cover crop plots, amounting to 1320.70 USD per hectare due to the expenses of establishing cover crops in the previous season. Despite these higher input costs, the increased yields and revenues from cover crops and direct seeding plots justified the investment. However, all maize treatments showed losses, with the highest loss being 93% in disc harrowed plots and the smallest loss being 4.5% in cover crop plots from on-farm trials.

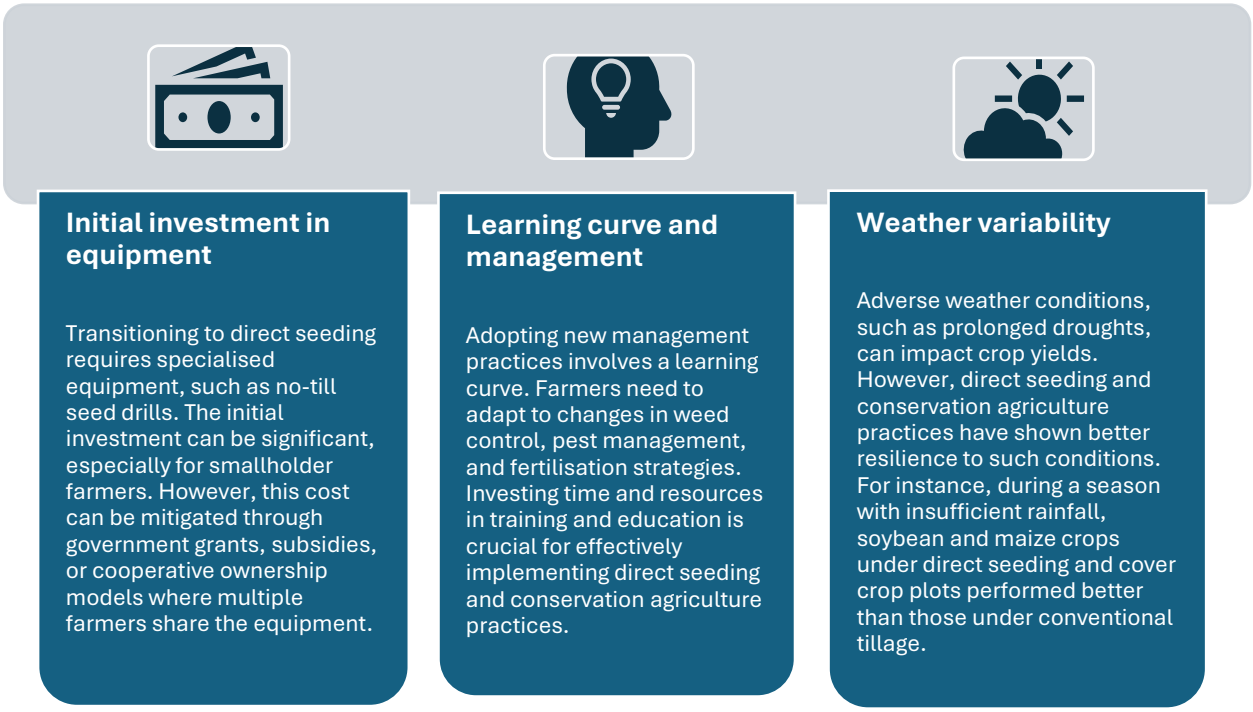
This information underscores the potential advantages of using direct seeding and cover crops for both soybean and maize production. These methods can lead to higher revenues and better economic returns despite the initial higher costs, making them a worthwhile consideration for farmers focused on cost savings.

Considering recent climatic fluctuations experienced across Sub Saharan Africa, mechanised CA is profitable even if all machinery is hired. However, smallholder farmers would need access to capital markets to hire the machinery and buy the inputs. Further, feasible approaches such as mechanisation service provision, which will enable most small and medium-scale farmers to access mechanisation services across Zambia, are required. Based on the first two years, the economic benefits of

are not lower than that of conventional practice – when considering a wet and a dry year and when considering the two typical crops – maize and soybean. This is important as it does not discourage farmers from adopting CA, even though the real benefits i.e. higher yields may only occur much later. These findings provide an agronomic and profitability outlook for mechanised agriculture with a focus on small and medium-sized farmers who can access tractor hire services.



Challenges and Recommendations



The cost-benefit analysis of direct seeding and conservation agriculture practices for soybean and maize indicates significant economic and environmental benefits. These practices reduce labour and machinery costs, improve soil health, and enhance yield stability. The economic analysis shows that direct seeding and conservation agriculture practices generate higher revenues as well as provide better returns on investment compared to conventional tillage methods.

Farmers considering the adoption of these practices should weigh the initial investment in equipment and the learning curve against the long-term benefits of improved soil health, yield stability, and profitability. Governments and agricultural organisations can support the adoption of direct seeding and conservation agriculture practices by providing subsidies, training programmes, and promoting cooperative ownership models. Farmers are encouraged to consider direct seeding and conservation agriculture as viable options to enhance their productivity and profitability while promoting sustainable farming practices.