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NOMINATION SUMMARY

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BSc(Hons) Agriculture with Mechanisation

Period studied	**From:**	**To:**
	2022	2026

Qualification to be gained:

BSc (Hons) Agriculture with Mechanisation

Project Title:

The impact of machinery utilisation and replacement decision in agricultural contracting business.

Details of material submitted with nomination: (Project/Exec Summary/videos etc)

Submitted project file

SIGNED BY PROPOSER: Graham Higginson	**DATE SUBMITTED:** 20th October 2026

If you wish to provide any additional information to support this nomination, please do so in a covering letter. When complete, return this form, together with the supporting documents, to

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Additional Notes.

Whilst Elen's project is not directly related to engineering sustainability, design or innovation, it provides an insight to the decisions that agricultural machinery operators must make in relation to machinery replacement. This provides direct linkage to the sustainability of the agricultural engineering supply chain. GH



The impact of machinery utilisation and replacement decisions in agricultural contracting business.

By

Elen Davies

being an Honours Research Project submitted in partial fulfilment of the requirements for the BSc Honours Degree in Agricultural with Mechanisation

2026

This form must be completed by the student and included at the beginning of the Honours Research Project.

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Major Project Title	The impact of machinery utilisation and replacement decisions in agricultural contracting business.
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Confidential?	NO

In submitting this Major Project I acknowledge that I understand the definition of, and penalties for, cheating, collusion and plagiarism set out in the assessment regulations. I also confirm that this work has not previously been submitted for assessment for an academic award, unless otherwise indicated

(Electronic) Signature of student: E M Davies

Date: 04/05/26

Table of Contents

Table of Tables ..... *i*

Table of Figures ..... *ii*

SUMMARY ..... *iii*

CHAPTER 1: INTRODUCTION *1*

CHAPTER 2: LITERATURE REVIEW *2*

2.1 Introduction 2

2.2 Machinery Economics 2

2.3 Tractor Utilisation 3

2.4 Machinery Cash Flow 4

2.5 Machinery Replacement Strategies 5

2.6 Maintenance and Repair Costs 6

2.7 New V Second-hand Machinery 8

2.8 Leasing Vs Purchasing 8

2.9 Research Gap 9

CHAPTER 3: METHODOLOGY *11*

3.1 Research Philosophy 11

3.2 Research Methodology Strategy 11

3.3 Data Collection 11

3.4 Data Analysis 12

3.5 Reliability and Validity 13

3.6 Ethics 13

3.7 Limitations 13

CHAPTER 4: RESULT *15*

4.1 Replacement Indicator and Decision Drivers 15

4.2 Tractor Operating Costs 16

4.3 Tractor Annual Utilisation 17

4.4 Utilisation Across Fleet Range 18

CHAPTER 5: DISCUSSION *19*

5.1 Machinery Replacement 19

5.2 Financial Timing and Residual Value 20

5.3 Human Behaviour and Operator Preference 21

CHAPTER 6: CONCLUSION *24*

Reference list *25*

Appendices *28*

Appendix 1 : Purchase invoices *28*

Appendix 2 29

Appendix 3: Tables showing all Excel data, all seven tractors and Claas

forager 880 30

Appendix 4 : Invoice showing annual cost of knife replacement and service to the Claas Jaguar 880 31

Table of Tables

Table 1 – Tractor Age, Annual Hours and Replacement Flag (Page 15)

Table of Figures

Figure 1 – Cost Per Hour by Tractor Model, Oldest to Newest (Page 16)

Figure 2– Annual Tractor Hours, Oldest to Newest (Page 17)

Figure 3 – Annual Hours for Selected Tractors Across Age Range (Page 18)

SUMMARY

The impact of machinery utilisation and replacement decisions in agricultural contracting business.

Davies, E, and Higginson, G.

BSc Agriculture with Mechanisation

Introduction: Machinery investment decisions play a crucial role in determining the financial performance and long term viability of agricultural contracting businesses. Agricultural machinery represents a major capital commitment, yet limited research exists on how utilisation and replacement decisions impact financial performance, specifically within UK agricultural contracting businesses.

Materials and Methods: Primary data were collected from a family run agricultural contracting business in West Wales through physical hour meter readings, purchase invoices, repair records and insurance quotes across a fleet of seven tractors and a forage harvester. The cost per hour was calculated for each machine using depreciation, repair and maintenance, insurance, and finance costs divided by estimated annual hours.

Results: Annual utilisation varied considerably across the seven tractor fleet, ranging from 728 hours per year on the JCB 4220 to 1,348 hours on the MF 7719s, with no clear linear relationship between tractor age and annual utilisation. Cost per hour also varied significantly across the fleet, ranging from £14.31 on the MF 7718 to £54.85 on the JCB 4220, driven primarily by the interaction of purchase price, length of ownership and annual utilisation rather than age or hours alone. The JCB 4220 recorded the highest cost per hour due to its high purchase price of £106,800, combined with monthly finance payments and the lowest annual hours in the fleet. Conversely, the MF 7718 recorded the lowest cost per hour despite being one of the older machines, benefiting from a lower purchase price spread across five years of ownership.
Three tractors, the MF 7726, MF 7718 and MF 7720, were flagged for replacement review on the basis of age alone, with repair costs across the entire fleet remaining well below the 15% of purchase price threshold associated with economically justified replacement. No clear relationship was identified between annual utilisation and replacement status, with the highest utilised machine showing no replacement indicator and several flagged machines recording above average annual hours, suggesting that utilisation has no direct impact on replacement decisions within the business, contrary to condition based models in the existing literature.

Conclusions: Replacement decisions within the business are driven primarily by age based planning cycles and residual value consideration rather than the condition based triggers that dominate the existing literature, challenging several assumptions embedded in current machinery management frameworks. Formalised utilisation monitoring through platforms such as AgDrive and adoption of the BPW iC hub system for trailed implements are recommended to enable more accurate and proactive fleet financial management.

Acknowledgments

I would like to express my thank you to all those who supported me throughout the completion of this Higher Research Project. First and foremost, I would like to thank my father and his agricultural contracting business for providing access to financial records, machinery data and operational knowledge that formed the primary data foundation of this study.

I would also like to extend my sincere thanks to my supervisor, Graham Higginson, for his guidance, feedback and support throughout the research process. His advice and encouragement have been invaluable in shaping the direction and quality of this project.

I declare that the work is my own work and that it meets the standards of academic integrity expected at all times as set out in the university academic integrity policy. I also confirm that this work conforms to the stated Artificial Intelligence guidance for this assignment brief and has not previously been submitted for assessment for an academic award, unless otherwise indicated.

CHAPTER 1: INTRODUCTION

Agricultural machinery represents one of the largest capital investments made by farming and contracting businesses in the UK, with tractors alone commanding a median expenditure of £62,800 per farm in 2023/24 (Defra, 2024). For agricultural contracting businesses, where machinery is the sole means of generating revenue, the financial stakes of machinery management are particularly high. Every hour a machine sits idle represents lost income, and every poorly timed replacement decision carries immediate financial consequences. Despite this, limited academic research exists that specifically examines how utilisation and replacement decisions impact financial performance within the UK agricultural contracting businesses, representing a significant gap in the existing literature.

This study seeks to address the gap by examining the impact of machinery utilisation and replacement decisions within the real agricultural contracting operation in West Wales. The study analyses fleet utilisation patterns, cost per hour performance and replacement decisions drivers across a diverse range of machinery, including tractors and forage harvester.

The aim of this study is to measure and analyse machinery utilisation and operating costs across the fleet, evaluate the factors driving replacement decisions within the business, and assess how effectively current machinery management practices support long term financial viability.

The objectives are to calculate the cost per hour for each machine using depreciation, repair and maintenance, insurance and finance costs. To identify replacement indicators based on age and repair cost benchmarks establishment decisions, also compare findings against published benchmarks and academic frameworks to identify areas of agreement, challenge or gap.

This report is structured as follows. Chapter 2 presents a review of the existing literature on machinery economics, utilisation, cash flow, replacement strategies, repair and maintenance costs, new versus secondhand machinery and financing options. Chapter 3 outlines the research methodology. Chapter 4 presents the results of the primary data analysis. Chapter 5 discusses the findings in relation to the existing literature, and Chapter 6 presents the conclusions, recommendations, and suggestions for future research.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The financial performance and long-term sustainability of agricultural enterprises are significantly influenced by the choices made regarding machinery investments. Effective capital asset management has become more crucial for contractors of all sizes as input costs continue to grow and profit margins are under pressure throughout the agricultural industry (AHDB, 2023). Tractors are essential to farming and agricultural contracting operations, making a significant share of overall capital investment in all farm machinery (Redman, G, 2024).

Within the wider agricultural industry, agricultural contracting businesses hold a unique position. Contracting firms rely only on their fleet of machinery to make money, in contrast to farming enterprises, whose machinery supports their own production activities. For every hour the machine is in idle is equivalent to lost revenue, and every badly planned replacement choice has immediate financial consequences (Olson,2004). Because of this variation, machinery management is especially important in contracting, where there is ongoing demand to maximise utilisation while keeping costs under control. These choices have become more complicated in recent years due to the rising costs and the rapid advances in agricultural technology, meaning contractors must now balance the financial burden of higher capital investment against the productivity and reliability advantages offered by newer machinery (Redman, G, 2024).

This chapter reviews the existing literature across seven key themes: machinery economics, tractor utilisation, machinery cash flow, replacement strategies, repair and maintenance costs, new versus second-hand machinery and leasing versus purchasing. Whilst a substantial body of literature exists on machinery management in farming contexts, a notable gap exists in research focused specifically on UK agricultural contracting businesses, where the combination of intensive seasonal utilisation, high capital investment and direct customer dependency creates a distinctive set of pressures that generic faming based models may not adequately address.

2.2 Machinery Economics

Tractors represent a major financial commitment for agricultural contracting businesses, with both high purchase prices and substantial ongoing operating costs. At a national level, farms in England spent a total of £2.3 billion on machinery in 2023/24, with tractors commanding the highest median expenditure of any machine type at £62,800 per farm, a figure that increased by 14% compared to the previous year (Defra,2024). Redman (2024) estimates the initial purchase cost of a 136.067kW tractor at approximately £138.088 with total annual costs of around £20,161 when depreciation, insurance, repairs, and fuel are considered. However, Defra (2024) found that farms spent a median of £92,000 on new tractors compared to just £30,600 on used machines, suggesting that contracting businesses purchasing secondhand equipment may face a considerably lower capital burden than these figures imply.

Beyond the purchase price, Olson (2004) emphasises that the financial burden of machinery ownership extends across a machines entire working life through

continuing operating costs. Depreciation is a partially significant component, with tractors typically retaining around 30% of their original value after ten years (Redman,2024). Olson (2004) warns that underestimating depreciation can leave businesses to undercharge for their service and make poorly timed replacement decisions, ultimately undermining long term financial sustainability.

Defra (2024) further reports that overall machinery expenditure fell by 3% in real terms between 2014-15 and 2023-24, suggesting a shift towards greater prudence in capital investment across the sector. For the contracting business in this case study, where a fleet of machinery generates a substantial cumulative cost burden, understanding the true economics of each machine is essential to both day to day financial management and well informed replacement decisions.

These numbers highlight the substantial capital burden that machinery places on companies of all sizes and show the extent of machinery investment throughout the agricultural sector. (Redman, G, (2024) offers a thorough analysis of tractor ownership costs for contracting companies in particular. It estimates that the initial purchase cost of a 185 horsepower tractor is approximately £138,088, with total annual costs of around £20,161 when depreciation, insurance, repairs and fuel are considered. Although these numbers are a helpful benchmark, it is important to remember that they are based on the cost of new machinery, which may lead to an overestimation of the financial burden experienced by contracting companies that mostly buy used equipment. Defra (2024) found that farms spent a median of £92,000 on new tractors and only £30,600 on used tractors. This finding highlights the significant cost difference between new and second hand purchases and suggests that second hand purchases can significantly reduce initial capital outlay.

2.3 Tractor Utilisation

Tractor utilisation, measured primarily through engine operating hours, is a key determinant of machine wear, maintenance requirements and overall economic life. According to industry guidelines, most tractors should last between 4,000-5,500 hours before needing substantial repairs, while many high end, contemporary models can last up to 8,000-10,000 hours with regular maintenance (Wickham Tractors, 2025). Hour readings are frequently used to evaluate the condition of tractors, and machines with less than 1,000 hours are thought to be lightly used, those with 2,000-2,500 hours indicate typical working use, and those with more than 3,000 hours need closer examination of key parts like engines and transmissions (Wickham Tractors, 2025). As a commercial dealer source, these benchmarks may reflect a commercially optimistic view of longevity and independent academic research on the hour threshold specific to UK agricultural contracting remains limited.

Landini (2022), suggests a modern tractor may achieve up to 15,000 operational hours over 10-15 years, though as a manufacturer source this figure should be treated with caution. In practice, contracting fleet frequently consist of a mix of contemporary and older machines operating productively well beyond traditional replacement thresholds. The contracting business in the study reflects this pattern, with tractors manufactures between 2016- 2023, providing a range of ages and cumulative hours across which utilisation trends can be examined.

When choosing replacement, the financial effects of tractor use are important and directly related. High annual working hours lower the effective cost per hour by increasing wear and depreciation while also allowing ownership expenditures to

be distributed across more productive time. On the other hand, because fixed ownership costs must be paid regardless of how much work machine completes, low annual utilisation may lessen mechanical stress but results in poor capital efficiency and poorer cash flow (Redman, G, 2024).

Dahab *et al*. (2021) further demonstrated that accumulated hours of use and tractor age are strongly correlated with increasing repair and maintenance costs, with an R^2 value of 0.93 indicating that hours and age together explain the vast majority of variation in repair costs. This result emphasises how crucial it is to keep a close eye on usage since machines accumulating hours quickly bring replacement forward, not delay it. When considered collectively, the data indicates that agricultural contracting companies must maximise annual tractor utilisation while keeping to good maintenance practices, in order to minimise hourly costs and efficiently schedule replacement decisions. Understanding the present utilisation rate of each tractor in the fleet is therefore a crucial first step in determining if each machine is producing a sufficient return on its capital cost for the firm under evaluation in this study.

2.4 Machinery Cash Flow

Cash flow is widely regarded as a key indicator of financial stability in agricultural businesses, particularly in enterprises with high levels of capital investment such as agricultural contracting, (Manachynska, *et al,* 2024). In contrast to profit, cash flow shows a companies true capacity to pay short term debt, such as loan repayments, operating expenses and continuing costs (Olson, 2004). Since medium term and long term loans or capital leases are frequently used to fund tractors purchases, contractors must consistently and sufficiently generate cash inflows from machinery operations to cover these liabilities. When evaluating machinery investment and replacement decisions, Olson, (2004) emphasises the significance of the debt and capital lease coverage ratio as a crucial indicator of whether a company earns enough cash to satisfy its anticipated loan obligations. This idea is further supported by Ibendahl (2012), who found a strong correlation between the timing of machinery purchases and farms having a relatively good income year. This suggests that replacement decisions are often influenced by cash flow and tax planning considerations rather than just machine condition or age. The fundamental idea that cash availability rather than equipment quality frequently determines replacement time is likely to apply equally to UK contracting enterprises, even if Ibendahl's analysis is based on US farming operations and UK tax systems may differ in their specific effects. This research illustrates the intricate relationship between financial management and machinery investment in practice and challenges the assumption that replacement decisions are made solely on the basis of rational economic consideration.

Cash flow risk for contracting businesses is further increased by the seasonal nature of the agricultural activities. Income during off season months, such as winter might be severely constrained, whereas demand for tractor based services usually surges from early spring to late summer. This results in noticeable spikes in cash flow interspersed with long stretches of time when fixed expenses, such as labour, insurance and machinery finance payments, must still be covered regardless of revenue levels. According to Redman, G, (2024), one of the biggest fixed cost commitments for contracting organisations is machinery loan repayments. This highlights the significance of making sure peak season revenue is adequate to meet the obligations all year long. Some agricultural contractors

set aside between 10-15% of their higher season profits as revenue to pay off season costs and preserve liquidity in order to handle this seasonal volatility, (Jones, 2024). It should be mentioned, nonetheless, that depending on the variety of service provided, the degree of seasonal cash flow risk varies significantly throughout contracting organisations.

Taken together, Redman, G, (2024), Jones (2024), Ibendahl (2012) and , Olson, (2004) suggest that three interrelated pressures. First, he demand of machinery finance commitments create a significant and recurring fixed cost obligation that must be met regardless of revenues levels. Second, the volatility of seasonal income means that cash generated during peak periods must be carefully managed to sustain the business through quieter months. Third, the timing of replacement decisions is frequently driven by cash availability rather than machine condition alone, further complicating financial planning. Each pressure reinforces the others and together determines the business's financial resilience. Understanding how these forces interact is crucial for managing daily liquidity as well as for making timely and financially sound machinery replacement decisions for the contracting company under investigation in this study, which engages in a wide range of year round operations.

2.5 Machinery Replacement Strategies

One of the most important financial decisions an agricultural contracting business must make is when to replace machinery, which has a direct impact on the operating costs, reliability and potentially long term profitability. According to research, a tractor's ideal economic life varies based on the model, yearly use and current repair prices (Khodabakhshian, 2011). By using regression analysis and the IBM SPSS Statistics programme, Kolhe, et al. (2024) generated an empirical model to predict the operational life of tractors based on their repair costs and annual hour usage. The analysis found that John Deere, New Holland, Massey Ferguson and SAME tractors reached their economic replacement point at five, six, seven and eight years respectively, after the cost of maintenance increased, making it economically unjustifiable. Nuthall et al. further identify that non quantifiable factors such as operator satisfaction, pride of ownership, and reduced risk of mechanical breakdowns may justify earlier replacement even when it's not economically required. A further research is added by Ibendahl, (2012), who find a strong correlation between farms having good income aligned with the timing of machinery purchases, suggesting that financial management and tax minimisation rather than machine condition or age are often the driving force behind the replacement decision. When combined, Nuthall et al. and Ibendahk (2012) make a strong argument that replacement decisions are influenced by both cost and personal preference. This viewpoint directly contradicts the condition based replacement models of Kolhe, et al. (2024) and Hunt (1988) which states that replacement is primarily promoted by rising costs in repairs.

Kubon, M *et al,* (2024) found that farm modernisation through new machinery purchases increased fuel consumption by an average of 8%, primarily due to higher powered tractors, without a corresponding increase in productivity, further challenging the notion that newer machinery inherently delivered better value. This finding implies that the financial case for replacing older machinery with newer machinery is not always as straightforward as it may seem. It is important for contracting businesses where fuel efficiency and operational cost control are crucial to commercial viability. Although Nutall, et al, identified improved operator

comfort and dependability as valid non quantifiable replacement drivers Kubon, M *et al,* (2024) shows that these advantages may come at a measurable cost in the form of higher fuel consumption and operating expenses. For contracting businesses, this conflict between the financial costs of upgrading and the operational advantages of newer technology is a real problem that the literature currently in publication fails to adequately address.

According to Edward, (ND), agricultural businesses frequently use a number of different replacement strategies such as annually planned replacement, or running the machinery until it can no longer perform. While planned replacement maintains a modern fleet and offers financial predictability consistent with the strategy recommended by Nuthall, et al. to minimise long term fixed costs, on the other hand keeping older machinery can result in lower capital expenditure but then raise risk of breakdowns and higher repair costs. Edwards (ND) acknowledges that decisions between these strategies is rarely influenced by a single factor, its influenced by a range of things like financial capacity and personal preference. However, neither Edwards (ND) or any other referenced used provided a replacement framework developed specifically for Uk agricultural contracting businesses, where the combination of intensive seasonal utilisation, high capital investment and direct customer dependency creates a distinct set of pressures on replacement decisions that generic farming based models may not adequately address.

Taken together, the literature presents a complex and sometimes contradictory picture of machinery replacement decision making. Whilst economic models such as PGP (2022) and Hunt (1988) provide useful frameworks for identifying optimal replacement points based on repair and trajectories, the evidence from Nuthall *et al*, Ibenhahl (2012) and Edward (ND) consistently demonstrates that the real world decisions are shaped by a broader range of financial, operational and behavioural factors. The absence of research focused specifically on replacement decision making within the uK agricultural contracting business represents a significant gap that the present study seeks to address through the collection and analysis of primary data from a real contracting business.

2.6 Maintenance and Repair Costs

Repair and maintenance costs, which account for a sizable and rising percentage of overall machinery ownership costs over time, are a major factor in determining the economic life of agricultural tractors. In the broader context of agricultural production, mechanisation costs make up 20-30% of total production costs (Science direct, 2015). In their earlier study, ASABE (2013 identified a considerably lower figure, finding that repair and maintenance expenses specifically account for 10-15% of total machinery expenditure. This distinction is important as the two figures measure different things. Mechanisation costs encompass all machinery related expenditure including depreciation and financing, whereas ASABE's figure isolates repair and maintenance alone. Both confirm that machinery costs represent a substantial and ongoing financial commitment. Over time, wear increases failure rates and the resultant maintenance costs. The significant long term financial burden that ageing machinery can place on a contracting business is highlighted by the fact that, in extreme circumstances, cumulative repair costs over a machines working life can reach as high as 80% of the original purchase price at roughly 10,000 hours of operation (Hunt,1988). Further research demonstrates, all tractor models immediately experience higher yearly maintenance costs as failure rates rise,

with certain models showing noticeably higher sensitivity to failure rate rises than others (Afsharnia et al., 2017). This model to model variation emphasises how crucial it is to take into account machine dependability characteristics in addition to age and hours when assessing maintenance cost risk, as opposed to using generalised standards for the entire fleet.

However, differences in repair costs between machines cannot be entirely explained by accumulated hours alone. Hunt (1988) discovered that operator skill, working conditions, and maintenance standards were equally significant predictors of repair costs, with hours of usage accounting for no more than 16% of observed variation. This conclusion is later corroborated by Khodabakhshian and Shakeri (2011), who shows that repair and maintenance costs differ significantly between machine types as well as between individual machines of the same model. As a result, fleet wide averages may mask notable variation at the individual machine level. This emphasises how crucial it is to monitor expenses at the machine level rather than depending solely on averages when choosing replacement. Additionally, Khodabakhshian and Shakeri (2011) discovered that tracking preventive maintenance activity offers a more trustworthy foundation for replacement decisions than simply keeping an eye on annual cost charges because it more accurately depicts the machines actual underlying condition rather than just its age or accumulated hours. Time constraints, however, may compel operations to put output ahead of maintenance during busy times, which could result in postponed servicing, greater failure rates and more expensive repairs later (IOP,2020). In agricultural contracting, where seasonal workloads are heavy and machinery downtime during crucial times like silage can have serious repercussions for customer relationships and business reputation, this conflict between operational demands and maintenance requirements is especially pertinent.

Additionally, the link between repair costs and annual utilisation is more complex than a straightforward linear relationship may imply. According to data from the Swiss farm survey, increased annual utilisation results in a disproportionately low increase in repairs and maintenance costs. This suggests an economy of scale effect, wherein equipment that operate more intensively accrue costs more slowly on an hourly basis, (ASABE, 2012). For agricultural contracting businesses, where high annual utilisation is a key component of operations, this has significant ramifications. Remarkably, it has been discovered that contractor owned tractors have lower repair costs than their farmer owned counterparts, accounting for 45.7% of list price at 12,000 hours as opposed to 55.4% (ASABE, 2013). Although ASABE ascribes this discrepancy to more rigorous maintenance schedules in contracting companies, it is important to remember that this study was carried out on Italian tractors, and the results might not apply directly to UK operating conditions, where different machine type, workload and maintenance practices are common. With an R2 value of 0.93, Dehab et al, (2021) further confirmed that tractor age and accumulated hours together account for the great majority of variation in repair costs. However, the authors point out that cost models differ greatly between nations and operating conditions, indicating that repair cost benchmarks derived from non UK studies should be applied cautiously in the UK contracting context.

In addition to tractors, specialist equipment like forage harvesters also have high maintenance and repair expenses. According to research, the costs of keeping forage harvesters technically ready drop as annual loading rises, from 13.63% - 3.12% for machines to accumulate 150 – 180ha annually (IOP, 2021). This

supports the claim that increased utilisation enhances the overall cost effectiveness of owning machinery when combined with efficient maintenance. Therefore, optimising annual throughput is not only commercially desired but also financially advantageous from a maintenance cost viewpoint for contracting enterprises operating forage harvesters across several customers and cuts per season.

When combined, the data from Hunt, (1988) ASABE, (2012, 2013), Afsharnia et al. (2017), Khodabahshian and Shakeri, (2011), Dahab et al. (2021) and IOP (2020,2021) indicated that a complex interplay of machine age, annual utilisation, operator skill, failure rates, and maintenance standards shapes repair and maintenance costs in agricultural contracting. Although expenses do increase with age and hours worked, the rate of increase is not constant and can be controlled with high annual utilisation and disciplined preventative maintenance. These results highlight the significance of monitoring maintenance costs at individual machine level throughout the fleet for the contracting company under investigation. This information along with utilisation statistics and failure rate trends, can be used to make timely financially sound replacement decisions.

2.7 New V Second-hand Machinery

Data from Defra (2024) show that farms spent £92,000 on new tractors compared to just £30,600 on second hand in 2023/24, with a difference of over 66% in initial capital outlay. This financial aspect is supported by Ruiz-Grace et al, (2022) who uses predictive analytics to show that the cost of used tratos varies with age, specifications and the operating hours, allowing purchasers to choose the best times to buy. Whilst their model was developed in a Spanish context and price may differ in the UK market, the principle that secondhand machinery offers a significant cost advantage relative to new is widely relevant across agricultural context.

However, the inherited reliability concerns must be balanced against the financial benefits of secondhand machinery. According to Kim et al, (2020) a basic flaw in uncontrolled secondhand in uncontrolled secondhand market is the lack of pre sale quality assurance. Dependability risks are significantly lower in situations where trustworthy dealers do pre sale maintenance and offer warranty protection, kim *et al* (2020) This is further supported by Nuthall, etal who identified reliability and breakdown risks as legitimate non quantifiable factors that may justify new machinery purchase even where financial analysis favours secondhand. Different to this ASABE (2013) found that contractors owned tractors incur lower repair costs than farmers who own tractors with 45.7% compared to 55.4% of list price at 12,000 hours, suggesting that the repair cost risk of secondhand machinery may be lower in well managed contracting businesses than these concerns imply, particularly offsetting the reliability argument in favour of new machinery.

Taken together, used machinery presents strong financial benefits for contracting businesses. However, in order to effectively manage reliability risk, it must be carefully sourced from reliable dealers with variable service histories.

2.8 Leasing Vs Purchasing

Contracting businesses long term financial success is impacted by the financial strategy used for agricultural machinery purchases. Rayner et al (1968), in one of the earliest econometric studies of UK tractor investment, found that tractor

purchasing decisions in the UK are heavily limited by available finance and taxation policy, with the real price of tractors relative to agricultural wages identified as the dominant explanatory variable in the UK investment behaviour. Financial availability is major influenced by machinery investment decision is still relevant today, even though this study was written in 1968 and the UK finance landscape has changed since.

Nair *et al.* (2004) provide a comprehensive framework for understanding the distinction between financial options available to rural enterprises, differentiating between finance lease, operating lease and outright borrowing. While an operational lease permits the business to use the asset for a predetermined amount of time while the lessor retains ownership and residual value risk, a finance lease distributes the majority of the risks and benefits of ownership to the lease while keeping the assets off the balance sheet. However, nair et al (2004) note that leasing is still an underutilised financing option in rural areas, in part because firm are not aware of the financial benefits it provides over traditional borrowing.

The valuation findings of Garcia et al (2022) whose predictive analytics model shows that machinery values fall sharply with accumulated hours and age, further support the financial argument for leasing. This residual value risk, which is substantial financial risk that leasing agreements convey to the lessor, is fully borne by businesses financing machinery through outright purchases or hire buy. Kim et al (2020) add another dimension, noting that the availability of warranty protection is a crucial factor in machinery decisions. Unlike secondhand purchases, where warranty protection is often lacking, operating lease agreements on new machinery usually preserve this advantage throughout the lease term.

Taken together, the evidence suggests that leasing offers contracting businesses meaningful advantages in terms of cash flow predictability and residual value risk. However, the decision between leasing and purchasing remains highly specific depending on the tax position of the business, the availability of suitable lease products and the strategic importance of asset ownership to the business model.

2.9 Research Gap

Whilst existing literature provides a broad foundation for understanding machinery economics, utilisation, repair costs and replacement strategies, a gap exists in research focused specifically on the context of the UK agricultural contracting businesses. The majority of studies reviewed, including those by Dahab *et al*, (2021), ASABE, (2012,2013), and Hunt (1988), were conducted in non UK context, meaning their findings must be applied cautiously to UK operating conditions where different machine types, workloads, maintenance practices and market conditions prevail. However, whilst condition based and cost driven replacement models such as those proposed by Kolhe e*t al* (2024) and Hunt (1988) provide useful theoretical frameworks, they fail to account for the behaviours, strategic and residual value consideration that evidence from Nuthall *et al*, Ibendahl (2012) suggests are equally influential in real world replacement decisions. No existing study has developed a replacement decision framework designed specifically for UK agricultural contracting businesses, where the combination of intensive seasonal utilisation, high capital investment and direct customer dependency creates a distinctive set of pressures that generic farming based models do not adequately address.

This study seeks to address these gaps through the collection of analysis of primary data from a real UK agricultural contracting business, providing an evidence based contribution to an underexplored area of agricultural business research.

The literature reviewed in this chapter highlights that all interconnected factors have an influence on the financial performance of agricultural contractors. Chapter 3 outlines the research methodology adopted to address the research gap.

CHAPTER 3: METHODOLOGY

This chapter outlines the research methodology adopted in this study, justifying the choice of quantitative and case study methods, describing how data was collected and analysed, and addressing reliability, validity, ethical considerations and limitations

3.1 Research Philosophy

This study adopts a positivist research philosophy, in which knowledge is derived from measurable, observable data treated as objective evidence (Saunders,*et al*, 2019). Positivism holds that reality can be measured and quantified, and that research should produce findings that are replicable and verifiable rather than subjective or interpretive. This philosophical position is well suited to the aim of the present study, which seeks to measure machinery utilisation, calculate financial performance and evaluate replacement decisions against quantifiable benchmarks. A positivist approach ensured that the findings of this study are grounded in verified financial data rather than opinion or assumptions, which is essential given the commercial sensitivity of the conclusions drawn.

3.2 Research Methodology Strategy

In line with this positivist position, a quantitative research methodology was adopted. A quantitative approach was selected in preference to a qualitative or mixed methods design on the basis that research objectives required precise financial measurements and direct comparison of machinery performance across the fleet (Saunders *et al.,* 2019). A qualitative approach, whilst potentially offering richer insight into the motivations behind replacement decisions, would not have enabled the systematic cost per hour calculations and utilisation comparisons that form the core analytical framework of this study this approach is consistent the quantitative methods employed in the key studies reviewed in the literature, including Dahab *et al.* (2021), whose regression analysis of repair costs and Kolhe *et al*, (2024), whose empirical replacement model, both demonstrate the suitability of quantitative methods for examining machinery financial performance. The primary data approach was selected specifically because the literature review identified a significant gap in UK contracting specific data, which secondary sources alone could not address. A single case study design was adopted in preference to a broader survey based approach, as the depth of financial data required, including individual machine repair records, purchase invoices and fiancé agreements, would be unlikely to be obtained from a large sample of businesses. Whilst this limits the generalisability of findings, it allows for depth of analysis that would not otherwise be achievable (Saunders, *et al.,* 2019).

3.3 Data Collection

The company selected is a family run agricultural contracting business based in West Wales. The business operates a wide and diverse fleet of machinery across a mixed rural area, undertaking a broad range of contracting operations, including forage and grass operations to slurry spreading and cultivation. Data was collected across two different machine categories. Seven tractors ranging in age from 2016 to 2023, and a forage harvester, providing a dataset covering different machine types, ages and utilisation patterns. Slurry tankers were excluded from the analysis as all four tankers are recently purchased and therefore do not have

sufficient repair and maintenance records or depreciation history to contribute meaningfully to the study. This exclusion was a deliberate methodological decision taken during the data collection process rather than an oversight. Silage trailers were also excluded from the analysis as, unlike tractors and the forage harvester, it was not possible to accurately track their utilisation through hour meters or load cycle data, meaning that when working out the costs, calculations could not be produced. This represents a limitation of the current study and highlights the need for dedicated implement tracking technology, such as a BPW iC hub system, which would enable accurate utilisation data to be captured from trailed equipment in future research.

For data collection, the researcher took actual hour meter readings from each machine on the yard. To ensure accuracy and provide a verifiable record, photographs were taken of the hour meter display and identification plate of each tractor, capturing both the current hours and machine details simultaneously. For the forage harvester, all data was captured directly from the cab display screen, recording both driving hours and drum hours separately.

Financial records and business invoices were thoroughly examined by the researcher. Documents reviewed included purchase invoices, (see appendix 1), repair and maintenance bills, service records and finance agreements, which provided a documentary evidence base for the key financial figures used in the analysis. Where the individual machine figures were not recorded separately, for example, the business held a single annual insurance policy covering the entire fleet, providing only an overall premium figure rather than a cost breakdown per machine. Additional steps were taken to obtain accurate individual figures. The local NFU Mutual office was contacted directly by telephone to obtain individual insurance quotes for each machine within the fleet, ensuring that insurance costs could be allocated accurately on a per machine basis rather than relying on estimated apportionments. This additional step significantly improved the accuracy and reliability of the cost per hour calculations.

Secondary data was gathered through a review of published academic literature, industry guidance and trade sources relevant to machinery economics, utilisation and replacement decisions. Academic databases, including Science Direct and ResearchGate, were used to identify peer reviewed journal articles and conference papers. Benchmark cost numbers from industry publications such as the John Nix Farm Management Pocketbook (Redman, G,2024) were used to compare the main data. Because they might represent commercial rather than strictly objective viewpoints, industry or trade sources, such as manufacturer websites, were recognised as such and handled as supplementary rather than primary academic evidence.

3.4 Data Analysis

A custom Microsoft Excel spreadsheet was designed to organise and analyse the data collected. Cost per hour was calculated by dividing each machines total annual costs, comprising repair and maintenance, insurance, finance payments and straight line depreciation, by estimated annual hours. Straight line depreciation was selected for its simplicity and consistency, allowing uniform comparison across the fleet, whilst acknowledging that it assumes a constant rate of value loss that may not fully reflect actual market depreciations, where values

tend to fall more steeply in early years of ownership. Data was presented visually through bar charts and tables produced in Microsoft Excel, as seen in Appendix 2, enabling direct comparison of annual utilisation and cost per hour across the fleet.

3.5 Reliability and Validity

Reliability refers to the consistency and reproducibility of the data gathering method, whilst validity relates to whether the data accurately measures what it is intended to measure (Saunders *et al,.* 2019). Hour meter readings were physically confirmed and photographed rather than recalled from memory, reducing the possibility of error. Insurance costs were verified through direct communication with the NFU Mutual rather than estimated. Purchase prices and repair costs were cross referenced with documentary evidence. The structured spreadsheet with standard formulas applied consistently across all machine types eliminated the possibility of inconsistent calculation. Were this study to be repeated, the methodology would produce comparable results, although hour meter readings would naturally be higher at a later point in time, meaning utilisation figures may differ slightly depending on hen data was collected.

3.6 Ethics

The primary data used in this study was collected from a family run business with the full knowledge and consent of the proprietor. To protect the commercial confidentiality of the business, the name and precise location of the operation have not been disclosed within this report.

3.7 Limitations

When interpreting the findings of this study, it is important to acknowledge a number of limitations. First, as this research is based on a single case study business, findings may not be directly transferable to other contracting operations of different sizes, structures or geographical locations. Secondly, whilst physical meter readings were taken directly from each machine, some financial figures, particularly annual repair costs for older machines, were not available from documentary records and were therefore estimated using the guidance from (Redman, G 2024), introducing a degree of uncertainty into the analysis. Third, the straight line depreciation method used assumes a constant rate of value loss over time, which may not accurately reflect the actual market depreciation of agricultural machinery, where values tend to fall more steeply in the early years of ownership. Fourth, the study is limited to a single point in time rather than a longitudinal study, which may affect the accuracy of annual utilisation estimates for certain machines. A mixed method approach incorporating structured interviews with the proprietor and operators was considered but rejected due to time constraints, though it is acknowledged this may have provided additional insight into the behavioural factor influencing replacement decisions, which emerge as a significant theme in the findings.

Finally, the researcher’s pre existing relationship with the business represents a potential source of bias in the interpretation of findings, which was managed through cross referencing financial figures against documentary evidence throughout.

This chapter has outlined the positivist quantitative methodology adopted, justifying the case study design and describing how primary and secondary data were collected and analysed. Whilst limitations are acknowledged, the methodology provides a robust framework for addressing the research question. Chapter 4 presents the results of the primary data analysis.

CHAPTER 4: RESULT

This chapter presents the findings of the analysis conducted across the contracting business machinery, drawing on the primary data collected. Together, these findings provide a comprehensive picture of how machinery is used and costed within the business, enabling a direct and evidence based response to the research question.

4.1 Replacement Indicator and Decision Drivers

The replacement indicator was calculated using two criteria, machine age exceeding seven years and annual repair costs exceeding 15% of purchase price consistent with benchmarks identified in the literature. Data for this analysis was drawn from physical hour meter readings, purchase invoices and repair records collected directly from the business.

Table 1 – Tractor Age, Annual Hours and Replacement Flag (Source: Authors own, adapted from Appendix 3).

Tractor	MF 7726	MF 7718	MF 7720	MF 7719s	MF 7722s	JCB 4220	Claas Jaguar 880	MF 7s 180
Age	9	8	8	6	5	5	4	2
Annual Hours / Drum Hours	825 / -	1131 / -	878 / -	1348 / -	1142 / -	728 / -	1896 / 1406	1217 / -
Replacement Flag	Yes	Yes	Yes	No	No	No	No	No

Table 1 shows that three tractors, MF 7726 (9 year old), MF 7718 (8 year old), and MF 7720 (8 year old) are listed for review due to age alone rather than repair cost limits, which are still far below 15% for the whole fleet. Notably, the data reveal no clear relationship between annual utilisation and replacement status. The JCB 4220, with the lowest annual hours in the fleet at 728, is not flagged for replacement, while the MF 7718 is flagged to be replaced with a record of 1,131 annual hours. Similarly, the MF 7719s, which record the highest annual hours at 1,348, show no replacement indicators confirming that utilisation is not a determining factor in replacement decisions within the business.

This pattern is further reflected in the forage harvester analysis. At the time of data collection, the Claas Jaguar 880 had accumulated 1,896 engine hours and 1,406 drum hours, equating to an average of 474 engine hours per year across four seasons of ownership.

4.2 Tractor Operating Costs

Cost per hour was calculated by dividing each tractor's total annual costs, comprising repair and maintenance, insurance, and straight line depreciation by estimated annual hours. Depreciation was calculated by dividing the purchase price by the number of years the machine has been owned by the business. First, the JCB Fastrac 4220, purchased in 2025 has been owned for less than one year (June 2025) at the time of data collection, so depreciation has been calculated over the three year finance period, giving an annual figure of £35,600. Secondly, the MF 7720, purchased second hand in 2023 despite being a 2017 year old tractor, records a higher depreciation figure due to its short two year ownership period.

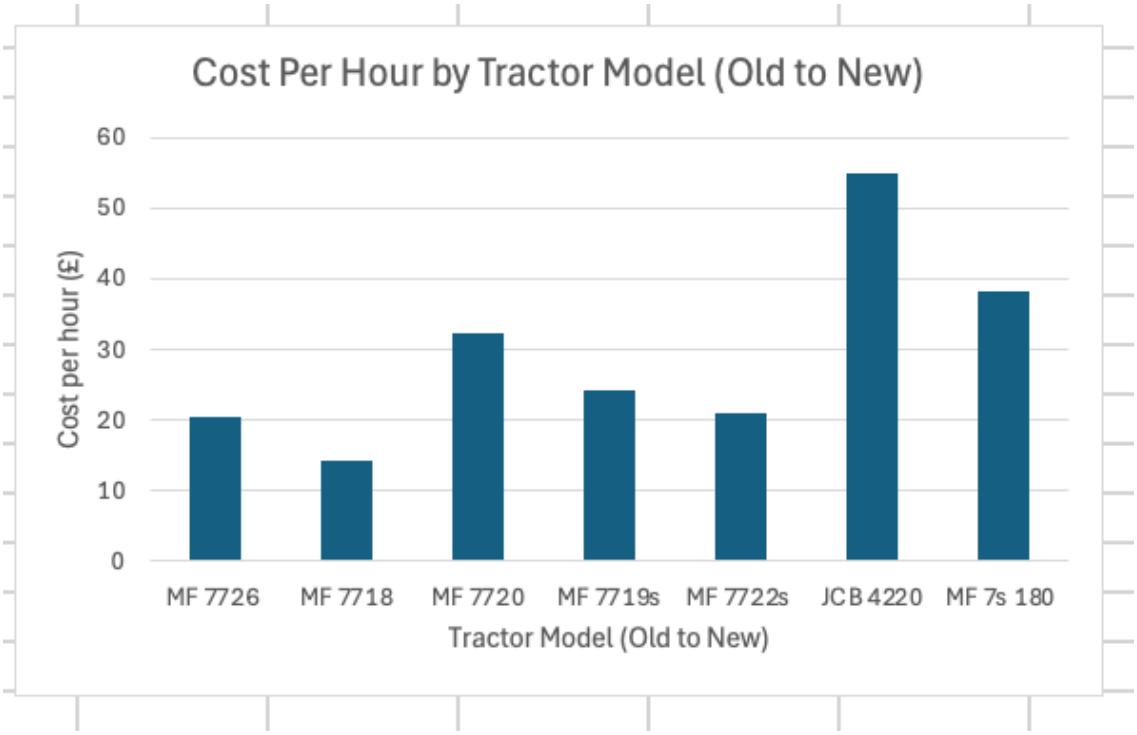


Figure 1 – Cost Per Hour by Tractor Model, Oldest to Newest *(Source: Authors own, adapted from Appendix 3).*

As shown in Figure 1, cost per hour varies considerably across the fleet, ranging from £14.31 on the MF 7718 to £54.85 on the JCB 4220. The JCB records the highest cost per hour primarily due to it high purchase price of £106,800, combined with the monthly finance and the lowest annual hours. The MF 7s 180, the newest tractor at £87,000, records the second highest cost per hour at £38.33, reflecting its high depreciation charge over only 2 years of ownership. Conversely, the MF 7718 records the lowest cost per hour despite being one of the older machines, benefiting from a lower purchase price and five years of ownership over which depreciation has been spread.

4.3 Tractor Annual Utilisation

Estimated annual costs were calculated by dividing total accumulated hours since purchase by the number of years each tractor has been owned. As illustrated in Figure 1, annual utilisation varies considerably across the fleet, ranging from 728 hours per year on the JCB 4220 to 1,348 hours on the MF 7719s. There is no clear linear relationship between tractor age and annual utilisation, with hours fluctuating across the fleet regardless of machine age.

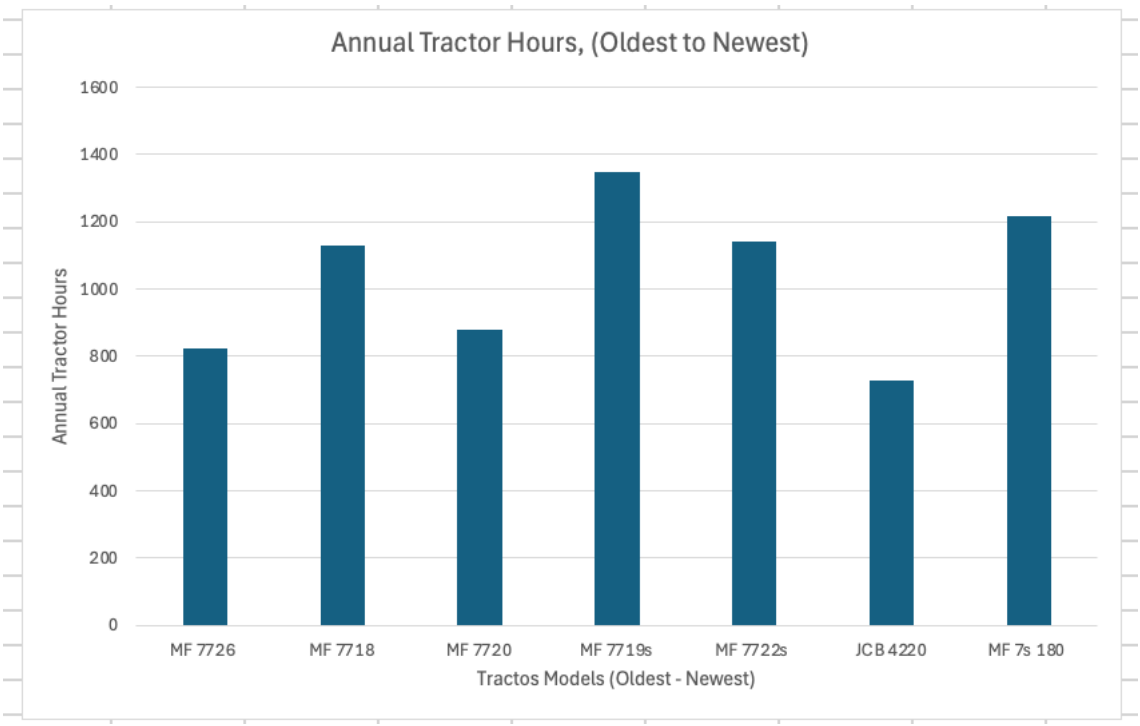


Figure 2– Annual Tractor Hours, Oldest to Newest *(Source: Authors own, adapted from Appendix 3).*

As illustrated in Figure 1, annual utilisation varies considerably across the seven tractor fleet. The MF 7719s records the highest annual hours at 1,348 whilst the JCB 4220 records the lowest at 728 hours per year. Notably, there is no clear linear relationship between tractor age and annual utilisation, with hours fluctuating across the fleet regardless of age.

To further support this finding, Figure 3 presents annual hours for a specific selection of tractor from oldest, two middle and newest.

4.4 Utilisation Across Fleet Range

Whilst figure 2 presents utilisation data across all seven tractors, Figure 3 isolates a targeted selection spanning the oldest, two middle fleet and newest machines in order to more clearly illustrate whether a pattern exists between age and annual hours. This approach allows a direct visual comparison across the fleet ages range.

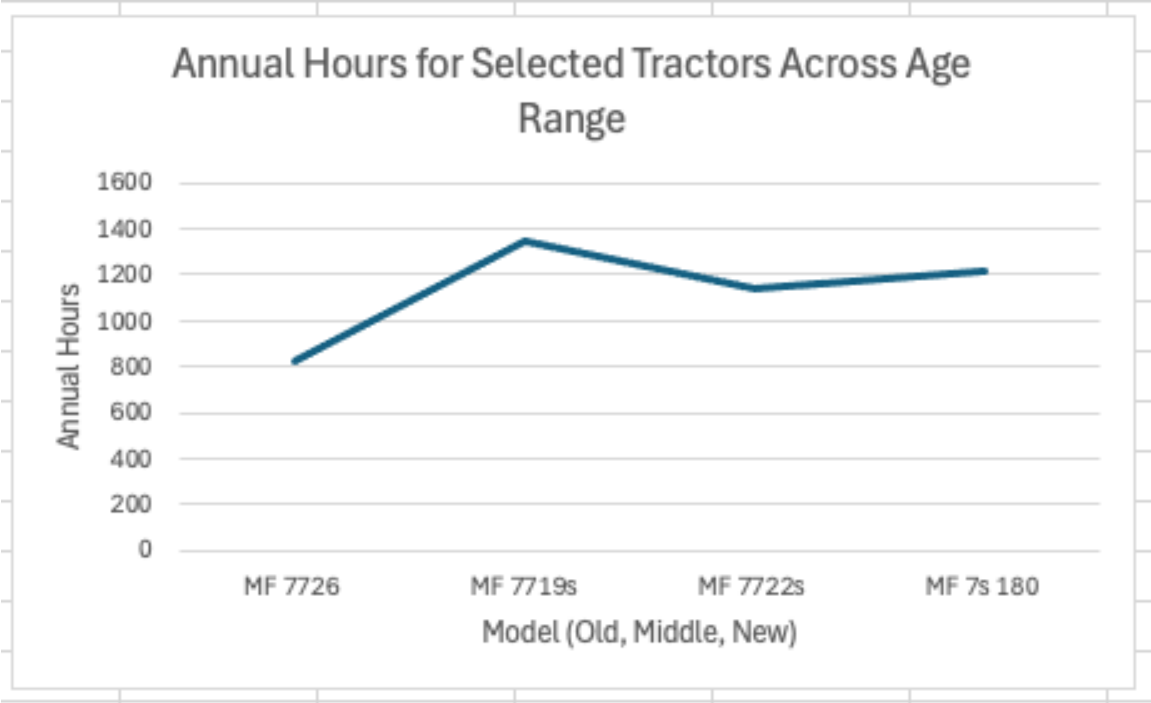


Figure 3 – Annual Hours for Selected Tractors Across Age Range *(Source: Authors own, adapted from Appendix 3).*

As illustrated in Figure 3, the MF 7726, the oldest machine in the fleet is flagged for replacement review by the business owner on the basis of age, records 825 annual hours. In contrast, the MF 7719s, an amid fleet machine with no replacement indicator, records the highest annual hours in the fleet at 1,348. The MF 7722s and 7s 180 both accumulate over 1,100 hours annually, yet neithr is approaching the replacement threshold currently set by the business owner. Taken together, these findings confirm that annual utilisation is not a determining factor in replacement decisions within this business. This diverges from the utilisation based cost efficiency arguments presented by Redman (2024) and Kay, Edwards and Duffy (2020), and instead supports the view that replacement timing in the business is governed primarily by age based rules and owner judgement rather than measured operational performance.

In summary, the replacement decisions are driven by age rather than repair costs escalation, cost per hour is shaped primarily by purchase price, ownership length and utilisation, and no meaningful relationship exists between annual hours and replacement status. These findings are discussed in Chapter 5.

CHAPTER 5: DISCUSSION

This chapter examines how the results from Chapter 4 relate to the existing literature reviewed in Chapter 2. The three main topics of discussion are human behaviour and operator preferences, financial timing and residual value, and machinery replacement decisions.

5.1 Machinery Replacement

The findings of this study reveal that tractor replacement decisions within the contracting business examined are shaped by a combination of age, business strategy, and financial planning rather than by the condition based triggers that dominate the existing academic literature. As it stands, three tractors MF 7726, MF 7718 and MF 7720, are currently marked for review due to their age. The company has an informal replacement cycle for tractors that lasts about eight years. Crucially, though, repair and expenses for the whole fleet are still far below the 15% of purchase price threshold usually linked to economically justified replacement identified by Hunt (1988) and ASABE (2013), with the MF 7726 having the greatest amount at just 5.8%. This implies that, from a purely mechanical standpoint, none of the tractors that have been flagged has reached the point where it is financially necessary to replace them, and that the decision to review them represents a strategic business preference for keeping a relatively modern fleet rather than a reactive response to declining machine condition consistent with the planned replacement strategy identified by Edwards (ND).

This result presents significant challenges as well as support for the existing literature. According to Kolhe *et al* (2024), the economic replacement point for tractors happens in five to eight years, depending on the model and maintenance cost history. This period is roughly in line with eight year cycle seen in this study. However, Kolhe *et al's* model assumes that replacement is triggered by escalating repair costs reaching an economically unjustifiable level, whereas in the business examined, replacement is planned in advance regardless of repair trajectory. This distinction is important because it implies that, without explicitly basing their choices on formal financial modelling, contracting businesses may, in reality, adopt planned replacement cycles that coincidentally align with the economically optimal replacement point identified in the literature. This adds to the expanding body of data suggesting strategic and behavioural considerations play an equally major role, challenging the idea in much of the previous research that replacement decisions are purely reactive and condition driven.

This interpretation is supported by Ibendahl (2012), who found a substantial association between the time of machinery purchases and farms having a successful revenue year. This suggests that financial opportunity and company strategy, rather than machine condition, typically influence when replacement occurs. This position is supported by the study's findings, rather than reacting to a particular mechanical trigger, the company replaces tractors on a planned cycle that reflects larger financial planning objectives. This conclusion is further supported by Nuthall et al, (1983) who found that in addition to purely economic criteria, non quantifiable factors such as owner preference, contentment, and risk aversion over possible failures have a considerable impact on replacement time. The informal eight year cycle observed in this study can therefore be understood not as an arbitrary decision but as a strategically informed policy that balances the financial costs of replacement against the operational risks of retaining ageing machinery beyond a point where reliability may become a concern.

An important nuance emerging from the results is that utilisation does not appear to directly influence replacement decisions within the business. The MF 7718, which is required to change according to Figure 3, has 1,131 annual hours, which is far more than numerous non flagged machine. In contrast, the JCB 4220, which has the lowest annual hours in the fleet at 728 is not flagged for replacement. This pattern implies that, in this business environment, age rather than hours worked is a more reliable indicator of when a machine approaches the end of its expected working life, directly contradicting the notion that high utilisation speeds up replacement by increasing mechanical wear, (Hunt 1988). This finding adds to the existing literature by Redham, G (2024) demonstrating that in agricultural contracting, where machines are used intensively but maintained to a high standard, age based replacement cycles may be a more practical and financially sound approach than the hour or repair and cost based models that dominate the academic literature. A further consideration is the JCB 4220, which records the lowest annual hours in the fleet at 728. However this figure should be interpreted with caution as the machine was purchased in June 2025 and not completed a full year of operation within the business at the time of data collection. Its low utilisation figure therefore reflects the short ownership period rather than any strategy decision to underutilise the machine, and its true annual utilisation rate is likely to be considerably higher once a full season of operation has been competed.

5.2 Financial Timing and Residual Value

The replacement strategy for the forager harvester demonstrates a more complex and commercially driven approach that goes beyond simple age of condition based considerations, even if age serves as the major trigger for tractor replacement within the firm. The company internally replaces the forager every 5 seasons in response to the financial dynamics of mechanical degradation and residual value rather than mechanical deterioration or rising repair expenses alone. This policy's justification is that, after around 5 seasons of ownership, the difference between the current machine's trade in value and the cost of a new replacement increases dramatically, making an earlier replacement financially attractive. This represents a fundamentally different approach to replacement decision making rather than that described in much of the existing literature, which tends to focus on repair cost escalation as the primary replacement trigger. The condition based replacement models of Hunt 1988 and ASABE 2013, which frame replacement as a response to cumulative repair costs approaching economically unacceptable levels, are directly challenged by this conclusion. In contrast to the £360,000 purchase price of the forager, in this study recalls annual repair and maintenance charges of £1,501 and knife replacement of £750, for a total of £2,251 (without tax) in wear related expenses. *See Appendix 4 .* This machine is far from its economic replacement point per the standard set forth in the literature. However, the company has a policy of renewing it every 5 seasons. This shows that residual value trajectory, as opposed to repair cost escalation, is the more pertinent financial factor for expensive specialised machinery like the forage harvester.

Nuthall *et al.(1983)* provide partial support for this replacement cycle because minimising fixed ownership costs over the long term often favours a defined replacement cycle rather than reactive condition based replacement. The idea is supported by the 5 season replacement strategy, which minuses the end cost and avoids the steep depreciation curve that characterises the later years of a high value machines working life by replacing when residual value is still strong. This strategy also aligns with Olson's (2004) financial management principles,

which highlight the significance of timing capital investment decisions to improve financial efficiency rather than merely avoiding short term operating costs.
Nonetheless, a thorough analysis of the potential financial benefits of prolonging the forager replacement cycle beyond five season is necessary. Over the course of four working seasons, the Claas Jaguar 880 had accrued 1,896 engine hours, 1,406 drum hours and 1,406 drum hours at the time of data collection. This amounts to an average of 474 engine hours per year, which is rather low for the machine and the value. With depreciation excluded, the total yearly expenses come to just £9,292, or £24.51 per engine hour. The machine would continue to create excellent margins in relation to its operating expenses, therefore the financial argument for the early replacement would be significantly remained at current levels after 5 seasons. According to ASABE (2013) and Hunt (1988), who both highlight increased repair costs as a function of cumulative hours and machine age, the main danger of extending the replacement cycle is accelerated repair costs as drum hours accrue. Nonetheless, at 1,406 drum hours, the forager is still well within the range where significant component failure would not normally be anticipated, indicating that there is a plausible argument for extending its operating life beyond the existing 5 seasons strategy from a strictly mechanical standpoint.

In the end, the choice depends how residual values in the market for used forage harvesters develop. The financial rationale for early replacement gets stronger if trade in values drop significantly between seasons five and seven. The argument for keeping the forager for more than 5 seasons becomes stronger if values stay comparatively stable, as it is typically the case for well maintained premium machines from top manufacturers. This analysis reveals a major gap in the literature, which typically ignores the significance of residual value dynamics in determining replacement time for high value specialist machinery in favour of repair cost as the main replacement trigger.

An alternative financial strategy worthy of considering is periodic lease or contract hire, whereby fixed lease payments replace capital purchase, and residual value risk transfers to the leasing company rather than remaining with the business. For high value specialist machinery such as the forage harvester, where replacement timing is driven by residual value dynamics rather than machine condition, an operating lease arrangement aligned to the exiting five season replacement cycle could offer significant advantages. Fixed monthly payments would improve cash flow predictability, lease payments can be offset against tax an annual business expense, making it more tax efficient than an outright capital purchase, meaning the business would be protected from the risk of residual value declining more steeply than anticipated. Redman, G, (2024) identifies operating lease and contract hire as increasingly common financing arrangements in agricultural contracting, noting their suitability for high value machinery with predictable replacement cycles. Whilst the business currently finances machinery through fixed term hire purchase arrangements, the evidence from this study suggests that transitioning the forager to an operating lease at its next replacement point could offer both financial and operational benefits worth evaluating.

5.3 Human Behaviour and Operator Preference

The human behavioural dimension is a less studied but no less important aspect of machinery management in agricultural contracting, even if the financial and age based aspects of replacement decisions are well documented in the literature

now in publication. The study's conclusions show a recurring trend of operators favouring newer equipment, which has a direct impact on tractor fleet utilisation rates and consequently forms the financial case for replacement. Older tractors are assigned to lesser demand jobs like headge cutting and general haulage, whereas modern tractors are routinely preferred by company operators for primary and higher intensity silage operations. This behaviour pattern is not formally documented or managed within the business but emerges naturally from the preferences and habits of those operating the machinery on a daily basis, (R, Smalley,2023)
The specific factors driving operators preference in this business extend beyond simple familiarity with newer equipment and encompass a range of comfort, convenience, and ergonomic considerations that have a direct, measurable impact on utilisation. The MF 7726, the oldest tractor in the fleet, currently operates without a functioning air conditioning system or a working radio, both standard features on all newer machines in the fleet. During intensive summer silage operations, where operators may spend extended periods in the cab in warm weather conditions, the absence of air conditioning represents a significant comfort disadvantage that actively discourages operators from selecting this machine for primary work. This is consistent with the University of Kentucky Agricultural Economics Department (2023) which identifies comfort and convenience as non monetary factors that frequently influenced capital investment and machinery management decisions in agriculture, noting that emotion and personal preference too often play a greater role than objective financial analysis in these decisions

Beyond comfort, the convenience of routine maintenance tasks alone influences operator preference in ways that are rarely acknowledged in the academic literature. In a contracting environment where the pressure during peak operational period is intense, even minor inconveniences in routine maintenance tasks can influence which machine an operator selects at the start of the working day. Cab suspension and technology integration also improve both operator comfort over long shifts and operational efficiency in the field. The Iowa State Ag Decision marker recognises this dynamic, noting that older machines are frequently allocated to lower intensity or less critical operations within the agricultural business, whilst newer equipment is consistently deployed on primary tasks and a pattern directly observed in this study.
This behavioural tendency has a substantial and quantifiable financial impact. With 825 annual hours, the MF 7726 has the fewest hours in the fleet. This number may be at least partly due to the operator unwillingness to use the machine because of its comfort and maintenance issues rather than any mechanical limitations. Because fixed ownership costs, such as insurance and depreciation, are dispersed over fewer productive hours due to this decreased utilisation, the machine's cost per hour rises to £20.42. Because of this, human behaviour creates a self reinforce cycle within the company. Operator preference lowers the use of older machines, which in turn raises the cost per hour. Higher cost per hour then strengthens the financial case for replacement, ultimately accelerating the machine's end of working life regardless of its actual mechanical condition. The best academic evidence for this pattern comes from Nuthall *et al.,* who provide the strongest academic support for this pattern, identifying operator satisfaction, pride of ownership as non quantifiable but legitimate influences on replacement decisions that operate alongside and sometimes override purely economic considerations.

This result makes a significant contribution to the body of research that treats the

use of machinery as an objective operational variable rather than one that is influenced by ergonomics, workplace culture and human behaviour. The result of this study indicates that certain identifiable comfort and convenience factors, such as cab climate control, suspension quality, and the availability of regular maintenance locations, can have a quantifiable financial impact on utilisation rates and cost per hour in agricultural contracting businesses that is not captured by traditional machinery management models. By identifying and actively managing these factors, such as making sure that air conditioning and other comfort features are kept operational throughout the fleet, it is possible to increase the utilisation rates of older machines, lower hourly rates on the newer tractors and prolong their financially viable working lives. Future studies that focus on particular ergonomic and comfort aspects that affect the choice of operator machinery in agricultural contracting would add significantly and creatively to this understudied field of literature.

CHAPTER 6: CONCLUSION

This study examined the impact of machinery utilisation and replacement decisions within a family run agricultural contracting business in West Wales. The findings confirm that utilisation and replacement decisions have a significant and measurable impact on cost per hour and long term financial performance, making them a central determinant of business viability.

Replacement decisions are driven primarily by age based planning cycles rather than condition based triggers that dominate the existing literature, supporting the behavioural arguments of Nutall *et al.* and Ibendahl (2012). For the forage harvester, residual value trajectory rather than mechanical deterioration drives replacement timing, highlighting a gap in the literature which consistently overlooks this as a strategic consideration. Operator preference for newer machines further reduces utilisation of older tractors, raising cost per hour and accelerating replacement in a self reinforcing cycle not captured by the existing frameworks.

Utilisation tracking should be formalised through a platform such as AgDrive, enabling real time monitoring of hours and profitability by machine and job type. For trailed implements, adoption of a BPW iC hub system would capture accurate load cycle data, addressing a notable limitation of this study. The business should formally document its informal replacement policy to strengthen financial planning and support long term succession.

The single case study design limits transferability, and the researcher pre exiting relationship with the businesses may have influenced interpretation. Future research should examine implement level financial contribution across multiple contracting businesses and develop a replacement decision framework specific to the UK agricultural contracting context, incorporating residual value dynamics and operator behaviour alongside traditional repair cost models.

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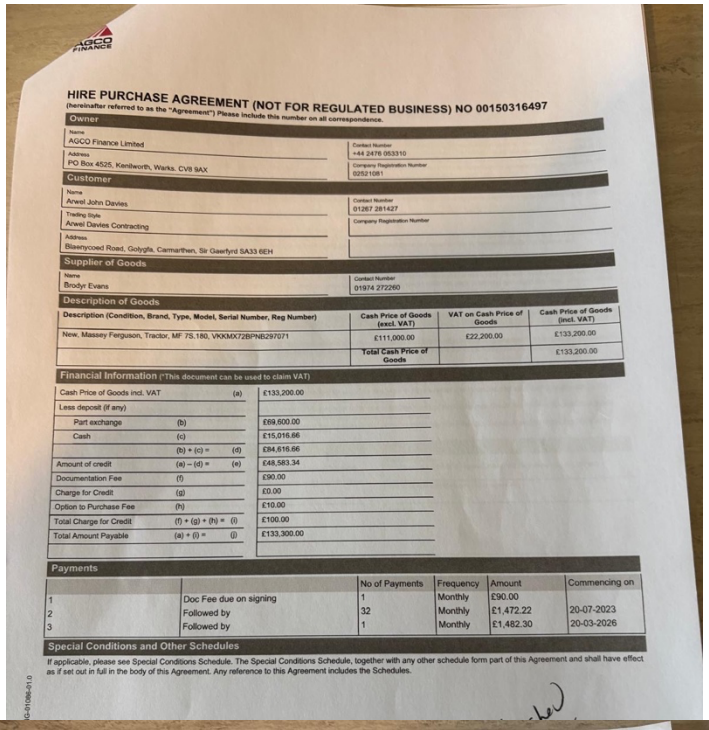
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Appendices

Appendix 1 : Purchase invoices



AGCO FINANCE

HIRE PURCHASE AGREEMENT (NOT FOR REGULATED BUSINESS) NO 00150316497
(hereinafter referred to as the "Agreement") Please include this number on all correspondence.

Owner

Name	Contact Number
AGCO Finance Limited	+44 2476 053310
Address	**Company Registration Number**
PO Box 4525, Kenilworth, Warks. CV8 9AX	02521081

Customer

Name	Contact Number
Arwel John Davies	01267 281427
Trading Style	**Company Registration Number**
Arwel Davies Contracting	
Address	
Blaencycoed Road, Golygfa, Carmarthen, Sir Gaerfyrd SA33 6EH	

Supplier of Goods

Name	Contact Number
Brodyr Evans	01974 272260

Description of Goods

Description (Condition, Brand, Type, Model, Serial Number, Reg Number)	Cash Price of Goods (excl. VAT)	VAT on Cash Price of Goods	Cash Price of Goods (incl. VAT)
New, Massey Ferguson, Tractor, MF 7S.180, VKKMX72BPNB297071	£111,000.00	£22,200.00	£133,200.00
	Total Cash Price of Goods		£133,200.00

Financial Information (*This document can be used to claim VAT)

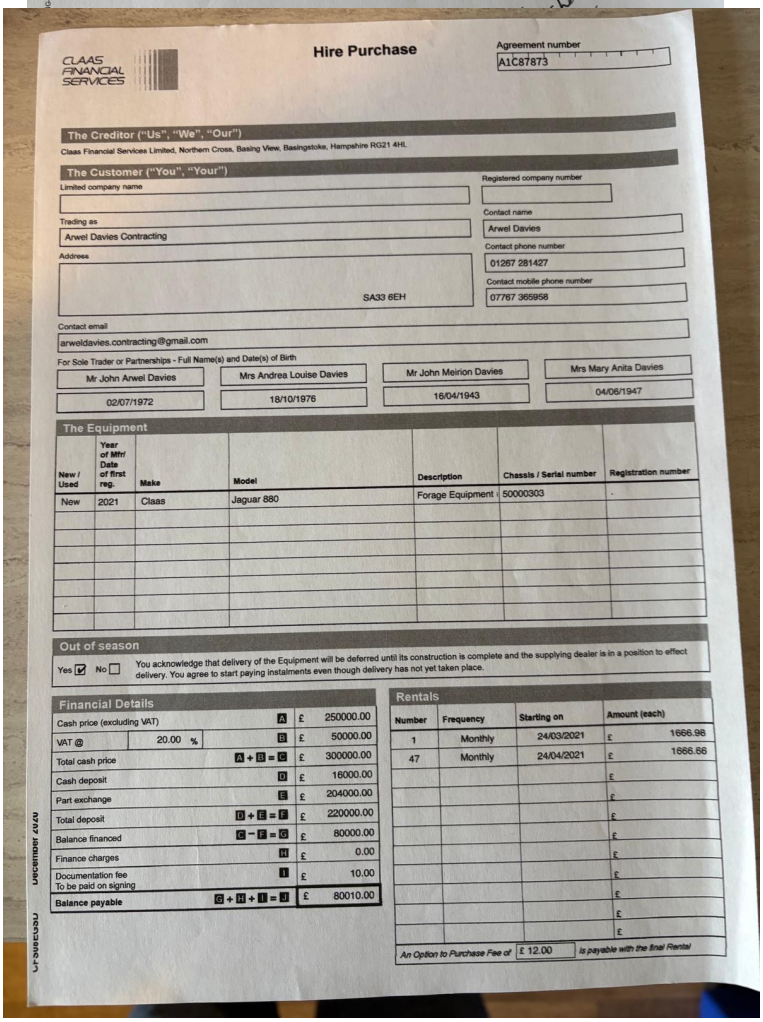
Cash Price of Goods incl. VAT	(a)	£133,200.00
Less deposit (if any)		
Part exchange	(b)	£69,600.00
Cash	(c)	£15,016.66
	(b) + (c) = (d)	£84,616.66
Amount of credit	(a) – (d) = (e)	£48,583.34
Documentation Fee	(f)	£90.00
Charge for Credit	(g)	£0.00
Option to Purchase Fee	(h)	£10.00
Total Charge for Credit	(f) + (g) + (h) = (i)	£100.00
Total Amount Payable	(a) + (i) = (j)	£133,300.00

Payments

		No of Payments	Frequency	Amount	Commencing on
1	Doc Fee due on signing	1	Monthly	£90.00	
2	Followed by	32	Monthly	£1,472.22	20-07-2023
3	Followed by	1	Monthly	£1,482.30	20-03-2026

Special Conditions and Other Schedules

If applicable, please see Special Conditions Schedule. The Special Conditions Schedule, together with any other schedule form part of this Agreement and shall have effect as if set out in full in the body of this Agreement. Any reference to this Agreement includes the Schedules.



CLAAS FINANCIAL SERVICES

Hire Purchase

Agreement number A1C87873

The Creditor ("Us", "We", "Our")

Claas Financial Services Limited, Northern Cross, Basing View, Basingstoke, Hampshire RG21 4HL

The Customer ("You", "Your")

Limited company name:

Registered company number:

Trading as: Arwel Davies Contracting

Contact name: Arwel Davies

Address: SA33 6EH

Contact phone number: 01267 281427

Contact mobile phone number: 07767 365958

Contact email: arweldavies.contracting@gmail.com

For Sole Trader or Partnerships - Full Name(s) and Date(s) of Birth

Mr John Arwel Davies	Mrs Andrea Louise Davies	Mr John Meirion Davies	Mrs Mary Anita Davies
02/07/1972	18/10/1976	16/04/1943	04/06/1947

The Equipment

New / Used	Year of Mfr / Date of first reg.	Make	Model	Description	Chassis / Serial number	Registration number
New	2021	Claas	Jaguar 880	Forage Equipment	50000303	

Out of season

Yes ☑ No ☐ You acknowledge that delivery of the Equipment will be deferred until its construction is complete and the supplying dealer is in a position to effect delivery. You agree to start paying instalments even though delivery has not yet taken place.

Financial Details

Cash price (excluding VAT)	A	£	250000.00
VAT @ 20.00 %	B	£	50000.00
Total cash price	A + B = C	£	300000.00
Cash deposit	D	£	16000.00
Part exchange	E	£	204000.00
Total deposit	D + E = F	£	220000.00
Balance financed	C – F = G	£	80000.00
Finance charges	H	£	0.00
Documentation fee To be paid on signing	I	£	10.00
Balance payable	G + H + I = J	£	80010.00

Rentals

Number	Frequency	Starting on	Amount (each)
1	Monthly	24/03/2021	£ 1666.98
47	Monthly	24/04/2021	£ 1666.66
			£
			£
			£
			£
			£
			£
			£
			£
			£

An Option to Purchase Fee of £ 12.00 is payable with the final Rental

Appendix 2 : Repair and maintenance invoices

Brodyr Evans Bros

£892.36

BILL
Due: 09/05/2025
Terms: None

#6781
09/05/2025

1 ACCOUNT

Repairs & MOT (2053) Taxable (20.0% S)	743.63
Subtotal	**743.63**
Tax is exclusive VAT @ 20% on 743.63	148.73
Total	**£892.36**

NOTES & ATTACHMENTS

Add notes or attachments

Brodyr Evans Bros

£725.09

BILL
Due: 28/05/2025
Terms: None

#6779
28/05/2025

1 ACCOUNT

Repairs & MOT (2053) Taxable (20.0% S)	604.25
Subtotal	**604.25**
Tax is exclusive VAT @ 20% on 604.25	120.84
Total	**£725.09**

NOTES & ATTACHMENTS

Add notes or attachments

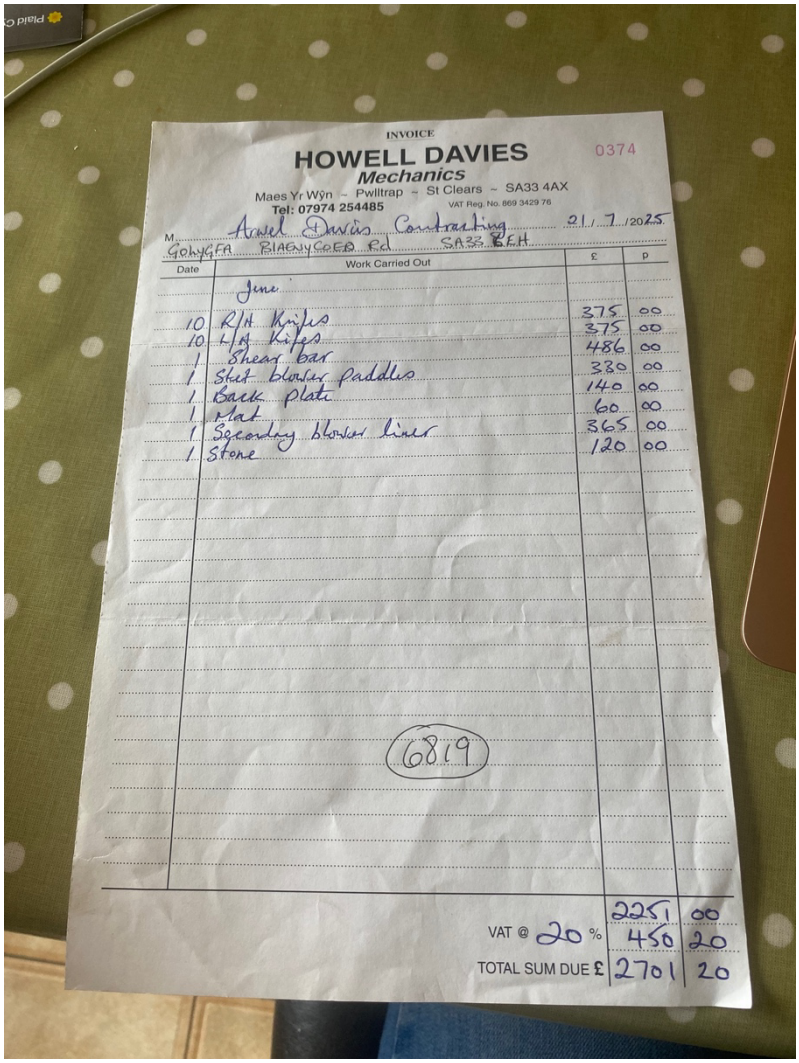
Appendix 3: Tables showing all Excel data, all seven tractors and Claas forager 880

Tractors — Data Collection							
Field	**Tractor 1**	**Tractor 2**	**Tractor 3**	**Tractor 4**	**Tractor 5**	**Tractor 6**	**Tractor 7**
A — Machine Identity							
Make	Massey Ferguson	Massey Ferguson	Massey Ferguson	Massey Ferguson	Massey Ferguson	Massey Ferguson	JCB Fastrac
Model	7718	7s 180	7719s	7720	7722s	7726	4220s
Year of Manufacture	2017	2023	2019	2017	2020	2016	2020
New or Secondhand?	Secondhand	New	Secondhand	Secondhand	New	Secondhand	Secondhand
Purchase Price (£)	£58,000	£87,000	£111,000	£50,000	£98,000	£78,000	£106,800
Year Purchased	2020	2023	2021	2023	2020	2018	2025
How it was purchased	Financed Fixed 3years	Financed Fixed 3years	Financed Fixed 3years	Financed Fixed 3years	Financed Fixed 3years	Financed Fixed 3years	Financed Fixed 3years
B — Hours & Utilisation							
Current Hour Meter Reading	8453.3	3666.4	8561.7	5366.2	6862.5	7858.1	3370.5
Hours at Time of Purchase	1670	14	1822	2732	8	1256	2643
Hours Accumulated Since Purchase	6783	3652	6740	2634	6855	6602	728
Estimated Annual Hours	1130.55	1217.466667	1347.94	878.0666667	1142.416667	825.2625	727.5
Period owned	6	3	5	3	6	8	1
Main Operations	Headgecutting	Ploughing + Haulage	Balling + Slurry Pumping	Haulage	Mowing + Hauladge	Mowing + Haulage	Mowing + Haulage
Annual Repair & Maintenance Cost (£)	£3,379	£1,244	£3,559	£2,203	£2,708	£4,489	£1,300
Annual Insurance (£)	£1,206	£1,906	£1,357	£1,146	£1,533	£1,213	£1,838
Annual Finance / HP Payment (£)	£0	£0	£0	£0	£0	£0	£1,197
Total Annual Costs (£)	£16,186	£46,650	£32,666	£28,349	£23,841	£16,844	£4,335
Depreciation Per Year (£)	£11,600	£43,500	£27,750	£25,000	£19,600	£11,143	£35,600
Cost Per Hour (£/hr)	£14.32	£38.32	£24.23	£32.29	£20.87	£20.41	£54.86
E — Replacement Indicator							
Age of Machine (years)	8	2	6	8	5	9	5
Repair Cost as % of Purchase Price	5.8%	1.4%	3.2%	4.4%	2.8%	5.8%	1.2%
Replacement Flag	Review	OK	OK	Review	OK	Review	OK

Forager Data Collection	
A — Machine Identity	
Make & Model	Claas Jaguar 880
Year of Manufacture	2021
New or Secondhand?	New
Purchase Price (£)	£360,000
Year Purchased	2021
How Purchased (e.g. new outright, secondhand HP)	Fixed 4 year finance
B — Hours & Utilisation	
Current Engine Hours	1896.19
Current Drum Hours	1406.44
Drum Hours as % of Engine Hours	74.2%
Engine Hours at Time of Purchase	12
Engine Hours Accumulated Since Purchase	1884
Estimated Annual Engine Hours	474
Estimated Annual Drum Hours	281.3
Main Season / Months Used	Summer
C — Annual Costs	
Annual Knife Replacement Cost (£)	£750
Annual Repair & Maintenance Cost (£)	£1,501
Annual Insurance (£)	£5,374
Annual Finance / HP Payment (£)	£1,667
Other Annual Costs (£)	£0
Total Annual Costs (£)	£9,292
Depreciation Per Year (£)	£90,000
Cost Per Engine Hour (£/hr)	£19.60
Cost Per Drum Hour (£/hr)	£33.03

Appendix 4 : Invoice showing annual cost of knife replacement and service to the Claas Jaguar 880

I



INVOICE

HOWELL DAVIES 0374

Mechanics

Maes Yr Wŷn ~ Pwlltrap ~ St Clears ~ SA33 4AX

Tel: 07974 254485

VAT Reg. No. 869 3429 76

M. Arwel Davies Contracting 21/7/2025

Gohygfa Riaeny Coed Rd SA33 6EH

Date	Work Carried Out	£	p
	June		
10	R/H Knifes	375	00
10	L/H Knifes	375	00
1	Shear bar	486	00
1	Steel blower paddles	330	00
1	Back plate	140	00
1	Mat	60	00
1	Secondary blower liner	365	00
1	Stone	120	00
	6819		
		2251	00
	VAT @ 20 %	450	20
	TOTAL SUM DUE £	2701	20