Unit 11: Understanding Principles of Land-based Machinery

Unit code: H/600/9643

QCF Level 3: BTEC National

Credit value: 10

Guided learning hours: 60

Aim and purpose

This unit aims to introduce learners to land-based machinery skills and knowledge and how these can be applied in practice. It is designed for learners in centre-based settings looking to progress into the sector or onto further/higher education.

Unit introduction

Modern land-based industries rely heavily on machinery and people working in these industries need a sound understanding of land-based machinery. It is an essential part of management that the correct equipment is chosen, operated and maintained properly to ensure efficient production. Fundamental to this understanding is a basic awareness of the principles of machinery systems and the maintenance required to keep such systems operating efficiently.

Throughout this unit, learners will develop their knowledge of the main components and power units found in land-based machines and understand their operation. The unit requires learners to maintain land-based machines and power units and to understand how these systems are used in the land-based industries.

Learning outcomes

On completion of this unit a learner should:

1 Know the function of key components found in land-based machines and power units

2 Understand operating principles of land-based machines and power units

3 Be able to undertake routine maintenance of land-based machines and power units

4 Understand the applications of land-based machines and power units.

Unit content

1 Know the function of key components found in land-based machines and power units

Power units: engine components; cooling systems; fuel systems; lubrication systems

Power transmission system: gears; drive shafts; belts; chains; bearings; clutches

Electrical system: alternator; battery; cabling; fuses; solenoids; sensors; motors; lighting

Hydraulic system: pumps; motors; pipes; control valves; filters; coolers; reservoirs

Attachments: types and position; drawbars; hitches; power take-off (PTO)

Operator systems: health and safety features eg ergonomic seat and working position(s), seat belts, safety cab, mirrors, signals, lights, windows, hearing protection, vibration reduction, air conditioning, global positioning systems (GPS), guards, fire extinguishers, communications; operators' manuals; training requirements; relevant legislation and codes of practice; personal protective equipment (PPE)

Control systems: function and position of controls; steering; brakes (independent, locked); wheels; tracks; skids

2 Understand operating principles of land-based machines and power units

Procedures: access and exit; pre-start and stop; attachments

Power units: 2-stroke cycle; 4-stroke cycle; liquid cooling systems; fuel types and systems; lubrication systems; air filtration systems

Power transmission systems: vehicle transmission eg tractor; chain drive eg baler, forage harvester; belt drive eg combine harvester, forage harvester

Electrical systems: alternating and direct current (AC and DC); voltage; power; power generation; fuses; solenoids

Hydraulic systems: pressure, flow, open centre; closed centre

3 Be able to undertake routine maintenance of land-based machines and power units

Health and safety and environmental protection: risk assessment; waste disposal eg oil, filters; correct use of hand tools and other equipment eg spanners, sockets, screwdrivers, jacks, lifts; relevant current eg legislation and codes of practice for example Health and Safety at Work Act 1974, Control of Substances hazardous to Health Regulations 2002 (COSHH); PPE

Routine maintenance: manufacturer's recommendations, manuals and data; pre-start checks eg oil levels; servicing schedules and requirements; cleaning; assessment of component, system and structure condition eg belts, chains, tyres, bearings; lubrication; replacement or repair of worn or damaged parts

4 Understand the applications of land-based machines and power units

Power unit: performance eg power, torque, fuel consumption; selection; mobile and fixed applications eg vehicle, generator

Power transmission system: performance; ratios; selection of transmission system; applications

Electrical system: starting; charging; lights; control; selection; applications

Hydraulic system: external power; linkage operation; transmission; braking; steering; selection; applications

Assessment and grading criteria

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all the learning outcomes for the unit. The criteria for a pass grade describe the level of achievement required to pass this unit.

Assessment and grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**
P1 identify key components used in land-based machines and power units	**M1** evaluate the main systems for given land-based machines suggesting areas that could be improved	**D1** explain the variation in pre-season, on-going and post-season maintenance and servicing requirements of a selected land-based machine's systems.
P2 state the purpose of the key components of selected land-based machines and power units		
P3 describe operator adjustments and control systems on selected land-based machines and power units		
P4 explain the operating principles of a selected land-based machine, power unit and power transmission systems	**M2** evaluate routine maintenance carried out for a selected land-based machine suggesting improvements.	
P5 compare the operating principles of the following systems to be found on land-based machines and power units • 2-stroke and 4-stroke power units • AC and DC electrical systems • closed and open centre hydraulic systems [CT]		
P6 describe the operating principles and service requirements for a liquid cooling system and air filtration system to be found on a land-based machines power unit		

P7	carry out risk assessments in preparation for performing routine maintenance tasks on selected land-based machine's and power units [SM]		
P8	carry out routine maintenance, according to manufacturers' recommendations, to a selected land-based machine [SM, TW]		
P9	complete documentation to record maintenance tasks carried out on a selected land-based machine		
P10	explain the applications of the power unit, transmission and hydraulic system on selected land-based machines		
P11	discuss operator settings available on power unit, transmission and hydraulic systems when operating a land-based machine		
P12	assess the effects on the performance of given land-based machines when changing operator settings on: • power unit • transmission system • hydraulic system		
P13	evaluate alternative designs of the following systems adopted by different manufacturers: • power unit • transmission system • hydraulic system. [IE, CT]		

PLTS: This summary references where applicable in the pass criteria, in the square brackets, the elements of the personal, learning and thinking skills. It identifies opportunities for learners to demonstrate effective application of the referenced elements of the skills.

Key	IE – independent enquirers	RL – reflective learners	SM – self-managers
	CT – creative thinkers	TW – team workers	EP – effective participators

Essential guidance for tutors

Delivery

Delivery of this unit will involve practical and written assessments and visits to suitable machinery collections. The unit links well to work-related experience placements.

Tutors delivering this unit have opportunities to use as wide a range of techniques as possible. Lectures, discussions, seminar presentations, site visits, supervised workshop practicals, research using the internet and/or library resources and the use of personal and/or industrial experience would all be suitable. Delivery should stimulate, motivate, educate and enthuse learners. Models and sub-assemblies could be used to demonstrate power units and systems.

Work placements should be monitored regularly in order to ensure the quality of the learning experience. It would be beneficial if learners and supervisors were made aware of the requirements of this unit before any work-related activities so that naturally occurring evidence can be collected at the time. For example, learners may have the opportunity to maintain the power unit, transmission, electrical and hydraulic systems of a given land-based machine and should be encouraged to ask for observation records and/or witness statements to be provided as evidence of this. Guidance on the use of observation records and witness statements is provided on the Edexcel website.

Whichever delivery methods are used, it is essential that tutors stress the impact that operating systems correctly can have on the overall performance of the land-based machine and on the environment. Tutors should also stress the importance of sound environmental management and the need to manage the resource using legal methods.

Health and safety issues relating to working in workshops and with agricultural equipment must be stressed and reinforced regularly, and risk assessments must be undertaken prior to practical activities. Following the production of suitable risk assessments, appropriate PPE must be provided and used.

Tutors should consider integrating the delivery, private study and assessment for this unit with other relevant units and assessment instruments learners are taking as part of their programme of study.

Outline learning plan

The outline learning plan has been included in this unit as guidance and can be used in conjunction with the programme of suggested assignments.

The outline learning plan gives **an indication of the volume of learning it would take the average learner** to achieve the learning outcomes. It is **indicative and is one way of achieving the credit value**.

Learning time should address all learning (including assessment) relevant to the learning outcomes, regardless of where, when and how the learning has taken place.

Topic and suggested assignments/activities and/assessment
Introduction and overview of the unit.
Assignment 1: Key Components and Systems (P1, P2, P3, M1) Introduction to the assignment.
Classroom lectures.
Practical machine-based demonstrations.

Topic and suggested assignments/activities and/assessment
Machine-based practice.
Production of portfolio evidence.
Evaluation and review.
Assignment 2: Understanding Operating Principles (P4, P5, P6) Introduction to the assignment.
Classroom lectures.
Practical machine-based demonstrations.
Machine-based practice.
Production of portfolio evidence.
Evaluation and review.
Visit to county show or trade exhibition – land-based machines.
Assignment 3: Practical Servicing (P7, P8, P9, M2, D1) Introduction to the assignment.
Practical preparation for servicing task(s).
Visit to service centre.
Classroom tasks. Introduction to documentation.
Servicing – Practical tasks.
Production of portfolio evidence.
Evaluation and review.
Assignment 4: Applying Principles of Land-based Machinery (P10, P11, P12, P13) Introduction to the assignment.
Classroom lectures.
Practical demonstrations of machine applications.
Practicals on applications, operator settings and performance.
Production of portfolio evidence.
Evaluation and review.

Assessment

For P1, learners must identify the key components used in land-based machines and power units. The components should be those of the main systems found on land-based power units and machines. Tutors should ensure that learners are familiar with the components of the main systems as detailed in the unit content. Suitable evidence could include logbooks, annotated photographs and tutor-led question and answer sessions.

P2 requires learners to build on the requirements of P1 by stating the purpose of the key components. Evidence could be in the same form as for P1.

P3 requires learners to describe operator and control systems found on land-based machines and power units. Tutors should ensure learners are familiar with the range of systems listed in the unit content. Evidence could be as for P1.

P4 requires learners to explain the operating principles of selected land-based machines and power units. Tutors should ensure that learners are familiar with the principles concerned with power, transmission,

electrics and hydraulics together with the relevant operating procedures. Evidence could be logbooks, observation records or a verbal or written report or presentation.

P5 builds on the knowledge needed for P4 by requiring learners to make comparisons of power units, electrical and hydraulic systems. Suitable evidence could be a PowerPoint presentation, logbooks or classroom notes.

P6 requires learners to develop P5 by describing the operating principles of liquid cooled power units and air filtration systems found on land-based power units. Tutors should ensure that learners relate this knowledge to the service requirements for these types of power unit. Evidence for P6 could be as for P5.

P7 requires learners to carry out risk assessments in preparation for performing routine maintenance tasks. Tutors should ensure that the risk assessments include safe working practices and environmental concerns, for example the legal disposal of waste oils and used components

P8 requires learners to carry out (using manufacturers' service data) routine maintenance of a selected land-based machine. Tutors should ensure that the size and complexity of the task is the same for all learners. Suitable evidence could be annotated photographs, logbooks and observation records.

P9 requires learners to complete documentation to record maintenance tasks carried out on a selected land-based machine. Evidence could be completed job sheets or other work record card appropriate for the machine.

For P10, learners must explain how the power unit, transmission and hydraulic systems can be applied to perform tasks in the land-based environment. This is concerned with how machines are used in the land-based context. Tutors should ensure that learners experience a wide variety of tasks and machines. Suitable evidence could include logbooks, tutor-led question and answer sessions and classroom notes.

P11 requires learners to discuss the operator settings available on power units, transmission and hydraulic systems. This requires learners to be able to adjust the settings of machine systems to enable the efficient completion of tasks. Tutors should ensure that learners experience the full range of machine systems and their various settings. Evidence could be as for P10.

P12 builds on P11 by requiring learners to assess the effects of changing operator settings. Observation records of practical tasks and logbooks would provide suitable evidence.

For P13, learners must evaluate alternative designs of power units, transmission and hydraulic systems. Learners need to examine how different manufacturers have adopted different approaches for the requirements of land-based power units and machine systems. A report, recorded discussion or PowerPoint presentation would provide suitable evidence.

M1 requires learners must evaluate the main systems for given land-based machines and identify appropriate areas that could be improved. This must include power unit, transmission, electrical, hydraulic and operator systems wherever relevant. This builds on the pass criteria for learning outcomes 1 and 2. Suitable evidence could be a report or PowerPoint presentation.

M2 requires learners to extend their experience of routine maintenance by evaluating their performance when carrying out this task. The maintenance task could be as for P7, P8 and P9. The emphasis is on the learner's recognition of areas where improvements could be made. A log book or recorded discussion would provide suitable evidence

D1 requires learners to explain the variation in pre-season, ongoing and post-season maintenance and servicing requirements of a selected land-based machines' systems. This must include power unit and transmission, electrical and hydraulic systems. The machine could be the same as that used to provide evidence for other grading criteria. Learners need to ensure they recognise that maintenance and servicing requirements will vary through the season and that they understand why. A report, a recorded discussion or a log book could provide suitable evidence.

Programme of suggested assignments

The following table shows a programme of suggested assignments that cover the pass, merit and distinction criteria in the grading grid. This is for guidance and it is recommended that centres either write their own assignments or adapt any Edexcel assignments to meet local needs and resources.

Criteria covered	Assignment title	Scenario	Assessment method
P1, P2, P3, M1	Key Components and Systems	Identify the key components and systems of land-based power units and machines. Include operator systems. State the purpose of the key components and describe the control systems. For a selected land-based machine, evaluate the main systems and suggest appropriate improvements.	Observation record(s). PowerPoint presentation. Classroom or lecture notes.
P4, P5, P6	Understanding Operating Principles	Explain the operating principles of a selected land-based machine, power unit and power transmission systems. Include liquid cooling systems and air filtration systems. Compare 2-stroke and 4-stroke power units, AC and DC electrical systems; closed and open centre hydraulics.	Classroom or lecture notes. PowerPoint presentation or written report. Recorded discussion.
P7, P8, P9, M2, D1	Practical Servicing	Carry out risk assessments in preparation to performing routine maintenance. Demonstrate the safe routine maintenance of a selected land-based machine and complete the required documentation. Evaluate the maintenance carried out and suggest improvements. Explain how seasonal maintenance may influence servicing.	Logbook. Observation record(s). Recorded discussion.
P10, P11, P12, P13	Applying Principles of Land-based Machinery	Explain how the power unit, transmission and hydraulic systems are applied to tasks in the land-based industries and what operator settings are available. Evaluate the different designs that manufacturers have for their power units, transmission and hydraulic systems.	Recorded discussion. Logbook. Observation Record(s). Report or presentation.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

This unit forms part of the BTEC Land-based sector suite. This unit has particular links with:

Level 2	Level 3
Introduction to Land-based Machinery Operations	Understand Farm Power Units – Machinery and Operation
Introduction to Principles of Land-based Machinery	Undertaking Land-based Workshop Practice
	Undertaking Land-based Machinery Operations

Essential resources

Learners will need supervised access to a well-equipped workshop suitable for the maintenance and repair of land-based machinery. A range of machinery, for example tractors and tractor sub-assemblies (such as engines, gearboxes and axles) will also be required to ensure that learners experience the systems around which this unit focuses on. A range of appropriate tools will be required as will the necessary supports, jacks, etc. Appropriate facilities for the disposal of waste products such as oil and filters will also be required.

Tutors delivering this unit should be competent and experienced in the operation and maintenance of land-based machinery. Ideally, they should have recent industrial experience within the service industry or show evidence of regular contact with the industry and/or technical updating.

Employer engagement and vocational contexts

This unit offers a wide range of opportunities for employer engagement and vocational contexts. Learners would benefit from experience of observing a service facility for land-based machines and power units. Work placements might also offer opportunities to for learners to practise the skills they have. The practical nature of the unit lends itself to real vocational contexts since many institutions offering the unit will have a range of land-based machines and power units that will need regular maintenance. In all cases, tutors should ensure that learners are adequately supervised and work within their level of competency.

Indicative reading for learners

Textbooks

Bell B – *Farm Machinery* (Old Pond Publishing, 2008) ISBN 1903366682

Landers A – *Resource Management: Farm Machinery* (Farming Press, 2002) ISBN 0852365403

Whipp J and Brooks R – *Transmission, Chassis and Related Systems, 3rd Edition* (Thomson Learning, 2001) ISBN 186152806X

Journals

Farmers Guardian

Farmers Weekly

Profi International

Websites

www.bagma.com	British Agricultural and Garden Machinery Association
www.defra.gov.uk	Department for Environment, Food and Rural Affairs
www.howstuffworks.com	Explanatory website
www.hse.gov.uk	Health and Safety Executive
www.iagre.org	Institution of Agricultural Engineers
www.lantra.co.uk	Sector Skills Council for the environmental and land-based industries

Delivery of personal, learning and thinking skills (PLTS)

The following table identifies the PLTS opportunities that have been included within the assessment criteria of this unit:

Skill	When learners are ...
Independent enquirers	identifying questions concerning the changes in performance through varying operator settings
Creative thinkers	asking questions to make comparisons between power units, transmission and hydraulic systems questioning the impact of changing operator settings on the performance of land-based machines looking at alternative solutions that manufacturers have incorporated into the design of land-based machines
Team workers	taking responsibility for carrying out routine maintenance of land-based machines
Self-managers	managing the risks associated with the routine maintenance to land-based machines organising time and resources to enable maintenance of land-based machines
Effective participators	identifying improvements in land-based machine design.

Although PLTS opportunities are identified within this unit as an inherent part of the assessment criteria, there are further opportunities to develop a range of PLTS through various approaches to teaching and learning.

Skill	When learners are ...
Independent enquirers	using manufacturers' repair manuals and analysing and evaluating their recommendations
Creative thinkers	devising innovative ways of improving maintenance procedures
Reflective learners	reviewing and reflecting on maintenance tasks undertaken
Team workers	taking responsibility for team maintenance tasks on land-based machines
Self-managers	faced with time limited maintenance tasks
Effective participators	presenting reasoned arguments for following a course of action when servicing machines as a group.

Functional Skills – Level 2

Skill	When learners are ...
ICT – Use ICT systems	
Select, interact with and use ICT systems independently for a complex task to meet a variety of needs	using online manufacturers' databases for servicing and maintenance solutions
Use ICT to effectively plan work and evaluate the effectiveness of the ICT system they have used	
Manage information storage to enable efficient retrieval	maintaining service records for machines and power units
Follow and understand the need for safety and security practices	
Troubleshoot	
ICT – Find and select information	
Select and use a variety of sources of information independently for a complex task	
Access, search for, select and use ICT-based information and evaluate its fitness for purpose	researching the purpose of key components of land-based machines and power units
ICT – Develop, present and communicate information	
Enter, develop and format information independently to suit its meaning and purpose including: • text and tables • images • numbers • records	
Bring together information to suit content and purpose	researching key components and systems of land-based machines and power units
Present information in ways that are fit for purpose and audience	preparing a presentation on alternative designs of power units, transmission and hydraulic systems used by different manufacturers
Evaluate the selection and use of ICT tools and facilities used to present information	
Select and use ICT to communicate and exchange information safely, responsibly and effectively including storage of messages and contact lists	

Skill	When learners are ...
Mathematics	
Understand routine and non-routine problems in a wide range of familiar and unfamiliar contexts and situations	
Identify the situation or problem and the mathematical methods needed to tackle it	
Select and apply a range of skills to find solutions	using numerical solutions to servicing requirements, for example fuel mixes, torque
Use appropriate checking procedures and evaluate their effectiveness at each stage	
Interpret and communicate solutions to practical problems in familiar and unfamiliar routine contexts and situations	
Draw conclusions and provide mathematical justifications	
English	
Speaking and listening – make a range of contributions to discussions and make effective presentations in a wide range of contexts	describing comparisons between 2- and 4-stoke power units, AC and DC electrical systems and open and closed centre hydraulic systems
Reading – compare, select, read and understand texts and use them to gather information, ideas, arguments and opinions	following manufacturers handbooks specifying routine servicing and maintenance requirements
Writing – write documents, including extended writing pieces, communicating information, ideas and opinions, effectively and persuasively	completing risk assessments in preparation for performing routine maintenance tasks.