



Food and Agriculture
of the Organization
United Nations



African Conservation
Tillage Network



**SUSTAINABLE AGRICULTURAL MECHANIZATION
HIRE SERVICES AS A BUSINESS ENTERPRISE**

MODULES FOR TRAINING OF MECHANIZATION HIRE SERVICES' PROVIDERS







Food and Agriculture
of the Organization
United Nations



African Conservation
Tillage Network

Sustainable Agricultural Mechanization Hire Services as a Business Enterprise

Modules for Training of Mechanization Hire Services' Providers

African Conservation Tillage Network (ACT)
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PREFACE

In the African countries' endeavour to achieve zero hunger by 2025 and prosperity as envisioned by the African Union Agenda 2063, a radical transformation in agriculture is necessary. Prioritized interventions will also need to address the economic setbacks brought about by the COVID-19 pandemic, for increased food quality and safety, which is also produced with less natural resources to be commercially, environmentally and socio-economically viable and sustainable. COVID-19 social distancing requirements demands far fewer people to achieve production tasks efficiently and timely, ideally feasible with CA and Sustainable Agricultural Mechanization (SAM) practices. Indeed, if fully embraced, SAM will significantly contribute to restoring agricultural production by increasing productivity and sustainability in addition to enhancing effective and safe machinery hire service provision.

Increased productivity and profitability of farming, needs to be demonstrated to attract increased public and private investments. Investments should focus on the necessary infrastructural and capital investments for the professionalization of small and medium scale farmers increasing their capacity to supply local and urban markets as well as artisans and small agro-industries.

FAO is supporting the African Union to promote sustainable agricultural mechanization across the continent to boost agricultural production and land and labour productivity. The goal is improving incomes and livelihoods of farmers and feeding a growing and rapidly urbanizing population presently dependent, to a larger extent, on food imports. Approximately 60 percent of Africa's population earns a living from agriculture and there is great potential to increase the profitability of smallholder farming, reducing postharvest losses, and adding value to the products through the transformation of agricultural products. This can provide new job opportunities for women and youth. Furthermore, sustainable agricultural mechanization – from simple hand tools to more sophisticated and motorized equipment, can ease the burden of hard physical work, reduce labour shortages and can also lead to better market access by improving food quality and safety, add value to products, and improve logistics and transportation.

At the request of the African Union (AU) and AU member countries, FAO supported the Department of Rural Economy and Agriculture of the African Union Commission to develop the Sustainable Agricultural Mechanization: A Framework for Africa (<http://www.fao.org/3/CA1136EN/ca1136en.pdf>). This framework, the product of a long, Africa-wide consultative process, provides guidance on tackling challenges and promoting greater uptake of sustainable mechanization.

The FAO and ACT signed a Memorandum of Understanding in Rome Italy in February 2019 to, among other things, support the implementation process of the SAMA Framework. This was followed by the FAO/African Union Commission/ACT Regional Meeting on Advancing the Operationalization of the Framework for SAMA held on 23 – 24 May 2019, in Addis Ababa, Ethiopia.

To carry out the framework's recommendations, FAO (Investment Centre, Plant Production and Protection division and the Regional Office for Africa) in partnership with the African Conservation Tillage Network (ACT), jointly organized a [regional workshop](#) held in Kampala in December 2019. The workshop brought together practitioners, government officials, researchers, bankers

and representatives of farmers and international financing institutions, to share experiences and knowledge of sustainable mechanization practices along the value chain and explore ways to link good agronomic practices, like CA, with sustainable mechanization options. The workshop highlighted that finding the right business models is vital and that different models of mechanization service provision already exist and can be adapted to different situations. Digital solutions such as mobile phone technologies combined with GPS tractor trackers can be very useful to provide for the management of mechanization services. It was further noted that public-private dialogue, including those with farmers' organizations, is key to creating an enabling policy environment and building trust.

The *Modules for Training of Mechanization Service Providers Booklet* summarises the tools and approaches to be used by ACT and country partners in carrying out the country level capacity development for sustainable agricultural mechanization service providers (MSPs). The training for priority-identified modules emphasises developing skills on SAM thematic areas using adult and participatory learning techniques. Using ICT's, MSPs will be supported to network with each other for enhanced peer learning and to other SAM service providers including machinery, financing and information.

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ABBREVIATIONS & ACRONYMS

ACT	African Conservation Tillage Network
AU	African Union
CA	Conservation Agriculture
CSA	Climate Smart Agriculture
CIMMYT	International Maize and Wheat Improvement Centre
COVID-19	Coronavirus disease
GDP	Global Domestic Product
GPS	Global Positioning System
ICT	Information Communication Technology
KALRO AMRI	Kenya Agricultural and Livestock Research – Agricultural Mechanization Research Institute, Katumani
FAO	Food and Agriculture Organization of the United Nations
IIRR	International Institute of Rural Reconstruction
MAAIF	Ministry of Agriculture, Animal Industries and Fisheries, Uganda
MSPs	Mechanization Service Providers
NGO	Non-Governmental Organization
PTO	Power Take-Off
SAM	Sustainable Agricultural Mechanization
SAMA	Sustainable Agricultural Mechanization: A Framework for Africa
SUA	Sokoine University of Agriculture
ToBs	Training of Beneficiaries
4WT	Four Wheel Tractor
2WT	Two Wheel Tractor

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1 OUTLINE OF THE HIRE SERVICES AS A BUSINESS ENTERPRISE TRAINING AID

This Training Aid booklet compliments learning from the “Hire Services as a Business Enterprise, a Training Manual for Small-Scale Mechanization Service Providers” published by the Food and Agriculture Organization of the United Nations (FAO) and the International Maize and Wheat Improvement Centre (CIMMYT) in 2018. The learning approach places huge emphasis on the technical and the management aspects of the small scale mechanization business and better their understanding of Conservation Agriculture technologies and other climate smart practices.

The training aid booklet is intended for prospective trainers of hire service providers. In turn, the trainers offer training at two levels - level one for machinery operators directly offering mechanization services and level two for owners/managers of the enterprises involved in the provision of mechanization services. For level one, the training booklet provides basic skills and operational issues while level two covers investment and management issues in the provision of mechanization services. New and simplified booklets, including PowerPoint presentations, cartoons and infographics, should be prepared for the trainees at the two levels.

As one plans to utilize or use this training aid, it is important to understand the outline to be able to structure the training accordingly. The outline segments illustrate the content of the training aids and what one is expected to see in this guide. The outline highlights to the trainer, what the teaching aids on mechanization hire service as business and sustainable farming systems are all about and what is contained in each part of the training aid.

The training aid is divided into three parts based on the nature of the content:

- i) A Guide to the Trainer
- ii) Course Sessions
 - 1. Learning objectives
 - 2. Key concepts and discussion points
 - 3. Learning activities and/or exercises including objectives, materials, time and methods / procedures
 - 4. Review questions
- iii) Sources of additional/further reading/reference materials.

i) A guide to the Trainer

This section of the Training Aid provides a guide for facilitators to deliver effective and practical training to service providers that leads to positive change in mechanization hire service provision, adoption of Conservation Agriculture and improve farmers' access to mechanization inputs with the ultimate aim of increasing productivity and profitability.

ii) Course/Training Sessions

The training aids summarises the objectives to be achieved, befitting topics and sub-topics to be covered, materials required for the training, approaches and methods, the time allocations, and the tools to eventually assess or evaluate the effectiveness of the training. Selected learning activities / exercises are also highlighted to impart skills and general awareness on mechanization hire service provision and climate smart practices and technologies solutions. The section is concluded by review questions, discussed in the plenary as a quick check to critical issues that have been covered.

2 A GUIDE TO THE TRAINER

In preparation for the training, the trainer needs to be aware that hire service providers may lack formal training in the selection and maintenance of small-scale mechanization, Conservation Agriculture or the broader climate smart agriculture technologies; and the management of their businesses.

In facilitating this training, it is essential to understand how adults learn, the role of the trainer and participatory learning techniques that can be applied. Facilitators have an important task to deliver key messages, which must create interest and enthusiasm among the target group to learn and make decisions that lead to positive actions. The service providers are central to farmers' successes and their role as service providers is critical in not only enhancing access to mechanization services but also technical support to smallholder farmers for increased production and productivity.

In situations where the course is offered online, proper planning and preparation of training materials by the facilitators need to be put in place. The training content and structure can be customized based on the needs and machinery particularities of the target value chain(s). Thus, the training materials for the course have to be consolidated into suitable online materials supported by self-sequential PowerPoint presentations, infographics and relevant audios and/or videos, among others, that support administration of the course online trainings. The online median, supporting as a minimum the sharing of online file, adequately aiding the demonstration of the necessary practical and suitable for the target audiences has to be identified and utilized.

2.1. The Modules

Some of the instruction guides for trainers in each module for effective and adequate delivery of the training are as follows:

Module 1: The module provides an introduction to and an overview of a hire service as a business enterprise. It introduces trainees to mechanization -a vital input for smallholder farmers in the context of sustainable crop intensification, in particular CA and its economics.

Module 2: The module introduces trainees to various aspects of CA in the context of sustainable crop production intensification and SAM. The proven undesirable and detrimental features of conventional tillage practices - notwithstanding practiced on more than 95% of the farmed area in Africa - are exposed and compared to alternative CA-based climate smart practices. Furthermore, the module emphasises on farming as business.

Module 3: The module exposes trainees on how to assess the production environment and market: what it is, why it is important and how to carry it out. Assessment of the local area aims at appreciating the potential market for any services offered in terms of the predominant value chains/operations; and understanding the services available to support the mechanization provision business.

Module 4: The module deals with the technical and financial aspects of machinery selection. The module introduces the steps required for selecting power sources (both tractors and draught animals) and implements for specific tasks. The module imparts the skills required to understand the importance of selecting power sources and implements. Through an analysis of farming systems and other factors (e.g. costs, customers and priorities), it equips participants to make optimal selections of appropriate power sources and implements, helping them to identify critical factors and understand power sources and implement performance in the field.

Module 5: The module covers the general aspects of operation and maintenance of the power sources and machinery most likely to be used in a hire service business. The focus is on tractors (both two-wheel, 2WT, and four-wheel, 4WT), draught bovines, sprayers, planters, post-harvest equipment and pumps. The range of machinery may be expanded according to its relevance to the prevailing situation. A hands-on practical approach is recommended, as are visits to commercial machinery suppliers and workshop facilities. The module covers a wide range of topics related to the operation and maintenance of agricultural equipment.

Module 6: Managing a hire service involves diagnosis, planning, organization, leadership and control—running the business and its services in a way that is environmentally friendly. The module covers four basic areas in four separate sessions: Entrepreneurship and management in the hire service business; Hire service business organization; Managing hire service business operations, and Managing financial aspects of the hire service business.

Other important aspects that guide course facilitators to deliver trainings that lead to positive change in mechanization service provision and improve farmers access to these services may include the below listed.

2.2. Adult Learning

The target audience (service providers) in this course are mostly adults (men and women) and youth with experience, knowledge and skills. Each adult and youth brings to the learning; experience, preconceived thoughts and feelings that will be influenced by motivation, the amount of previous experience, the level of engagement in the learning process, and how the learning is applied. Learning something new is not just achieved in an instant. Referring back and making use of the knowledge and skills is the basis of the adult learning process. The new learning will have to be internalized (processed) by making it relevant to one's self. Remember the 20.40.80 principle of adult learning: Adults remember 20% of what they hear, 40% of what they hear and see, and 80% of what they hear, see, and do. It is advisable to use creativeness as much as possible. This will call for the involvement of practical experience.

2.3. The Role of the Facilitator

A facilitator has the primary role of an instructor who creates optimal environments for learners / trainees (men, women, youth and people living with disabilities (PWD)) to effectively learn by arranging opportunities for the learners to listen, observe and interpret the subject to carry out simple tests and exercises, and facilitate active discussions. The facilitator is also supposed to encourage participants to adopt an active role in the learning process through making use of suitable participatory approaches which engage the participants as much as possible.

The main featured attitudes and roles of a facilitator:

- To listen to participants (men, women, youth and PWDs) and respect their knowledge, experiences and perceptions,
- To give participants the confidence to share their knowledge and experiences,
- To create suitable conditions and activities from which participants can learn and exchange ideas and information,
- To be responsive to participants' needs and flexible in implementing the training,
- To increase participants' knowledge, skills and problem-solving ability.

2.4. Facilitation & Learning Techniques

Facilitation is a process, which is driven by a facilitator who manages a learning environment; through exchange of ideas; which involves ANALYSIS (detailed scrutiny or examination of an issue of common interest); which should lead to change or development.

Facilitation may include the following:

i) **Plenary introductions**

A plenary introduction is normally the first activity to start a new training session. Its' main objective is to create awareness on the subject and to familiarize the participants to some basic concepts by referring to familiar and related topics.

ii) **Brainstorming**

The main objective of a brainstorming session is to introduce new topics and to discover new ideas and responses very quickly by having the group describing the topic or idea by providing an exhaustive list of related characteristics and conditions.

iii) **Small group discussions**

Instead of discussing one subject with the whole group, more subjects can be discussed by using smaller groups. The main objective is to give every participant an opportunity to actively participate in the discussion.

iv) **Practical (field) activities also livestreamed**

To give participants the opportunity to go to the field and experience a new technology by watching and doing. One or two MSPs will be identified to undertake the practical training while maintaining social distancing. Additionally, the event will be livestreamed to the MSPs for them to learn and interact remotely. The objective is to learn through practicing new ideas.

v) **Plenary discussions and presentations**

The plenary discussions can follow directly after small group discussions, but does not need to do so. The objective of the plenary discussions/presentations is to synthesize the ideas of the participants about a (new) topic or information that has been discussed within the group.

2.5. Training Materials

Such materials as marker pens, flip charts, masking tape, posters, training manual and a session guide are needed for each practical training session. Fact sheets are particularly important especially if they are written in local language or dialect. However, if the training is virtual, emphasis will be on audio-visual training aids such as PowerPoint presentations, pictures and videos. Be prepared for illiteracy and adapt the training accordingly.

2.6. Training Evaluation Method

It is important to evaluate the training so that the trainer is informed about the impact of the training in terms of knowledge retention. Different training evaluation methods can be used e.g.:

- Pre- and post-tests
- Participants' feedback such as through recaps.
- Final training evaluation checklist

3 INTRODUCTION TO SUSTAINABLE AGRICULTURAL MECHANIZATION HIRE SERVICES AS A BUSINESS ENTERPRISE

3.1. Why the Course

Agriculture is the main part of livelihoods and employment for most Africans. The sector employs 65–70 percent of the African workforce, supports the livelihoods of 90 percent of Africa’s population, and accounts for about a quarter of the continent’s GDP. On average, agriculture contributes 15% of total GDP, however it ranges from below 3% in Botswana and South Africa to more than 50% in Chad implying a diverse range of economic structures (OECD/FAO, 2016). The importance of the agricultural sector is such that agricultural growth in sub-Saharan Africa is more effective in reducing poverty than growth in non-agricultural sectors. The development economics literature in Africa shows that an increase in agricultural productivity reduces poverty by raising farm and off farm incomes, improving health and nutrition, lowering food prices, and broadening wage employment opportunities. The place of agriculture in Africa’s economy cannot, therefore, be overemphasized, and improving the quality and standards of life of Africans will ultimately involve enhancing agricultural performance.

The agricultural sector in Africa still performs poorly as compared to other regions of the world and its enormous potential remains untapped. The continent still lags behind other regions of the world in terms of productivity, agricultural mechanization, advisory and extension services, and public spending. As a result, Africa remains the world’s most food-insecure region with more than one out of four Africans being undernourished, and the proportion projected to increase by 33 percent, from around 240 million in 2015 to around 320 million in 2025 (OECD and FAO, 2016). Although the Africa’s poverty rate declined from 57 percent in 1990 to 43 percent in 2012, still a large share of the African population continues to live below the international poverty line of \$1.90 a day.

The African Union and FAO launched and published in 2018, the Sustainable Agricultural Mechanization: A Framework for Africa (SAMA) premised on the guiding principle by Dr Nkosazana Dlamini Zuma, Chairperson, from 2012 to 2017, African Union Commission that *‘the current mechanization wave is to send the hand hoe to the museum and liberate the African farmer from the backbreaking drudgery of tilling the land by hand.’* The Framework is grounded on the need to make Africa’s agriculture to the driving seat of growth and development by focusing on private-sector-led, environmentally friendly,

climate-smart, but also economically viable and affordable agricultural mechanization, particularly for small producers, with particular attention to the role of women and youth.

The effective utilisation of mechanization as one of the essential inputs to the transformation of African agriculture faces a lot of challenges. Land fragmentation continues to pose challenges on mechanization as the land sizes become smaller and smaller. Besides, smallholder farmers often do not have the necessary capital, either as savings or via access to financial credit, to invest in the expensive farm power and machinery that is essential for raising land and labour productivity. Moreover, poorly selected or misapplied agricultural machinery can damage, rather than enhance, environmental resources, especially soils. Smallholder farmers require specialized mechanization services that are both environmentally friendly and productivity enhancing. Appropriately trained and equipped mechanization service providers can meet this critical need (FAO and CIMMYT, 2018).

This training of beneficiaries (ToBs) course is therefore intended to provide hire service providers, whether already in the business or intending to start their own mechanization hire service provision business, with knowledge, skills and competencies in both the technical and the management aspects of the small scale mechanization business. It also aims at providing a better understanding on CA technologies and other climate smart practices. This will ultimately enhance their service provision abilities and improve access to mechanization services to raise the productivity of smallholder farmers.

The development and implementation of this courses forms part of the project activities supported by FAO and implemented by ACT in 5 countries namely; Uganda, Kenya, Tanzania, Ethiopia and Zambia. The main objective of the project is to improve access to agricultural equipment in sub-Saharan African countries for the benefit of producers, particularly the poorest, through the development of service delivery. The project is part of the implementation of the strategic framework of sustainable agricultural mechanization (SAMA) developed in 2018 jointly by FAO and the African Union.

This course is important and critical to any trainer charged with the responsibility of increasing the supply of well trained and well-equipped entrepreneurial mechanization service providers capable of promoting sustainable agriculture (CSA/CA) through the implementation of tailored training specific to its location.

Over the last few years, online training has surged in popularity. People are generally busier and technology has made massive advances, making online learning a more attractive option when it comes to personal and professional development. With the COVID-19 pandemic and other restrictive conditions or uncertainties, online learning provides an alternative to accomplishment of the planned training and beyond in a convenient and safe manner. The training materials on hire services as a business enterprise consolidated into this booklet will be supported by PowerPoint presentations and videos to support the online trainings. The online median, supporting as a minimum the sharing of online files, will be selected from amongst others, Zoom, Skype or Microsoft Teams.

3.2. Course Objective

The main objective of the course is to raise awareness among tractor owners on the opportunities offered in sustainable agricultural mechanization service provision, build capacity of mechanization service providers (MSPs) to enhance their service provision and improve access to mechanization services by smallholder farmers. This will also enhance their understanding about Conservation Agriculture technology and practices and how to do quality mechanization service provision as business.

Specifically, the course is intended:

1. To create awareness to tractor owners on the investment opportunities offered by mechanization and SAM hire services provision.
2. To expose tractor owners and MSPs on the role of CA for sustainable businesses with increased agricultural productivity and environmental compatibility.
3. To create awareness to machinery operators on the business opportunities and profitability offered by SAM hire services provision.
4. To enable service providers and other key stakeholders acquire new knowledge on technical, operational and financial aspects of machinery; learn from each other, share knowledge, networking and create partnerships on SAM service provision.

3.3. Course Outputs and Outcomes

It is expected that at the end of the course, the following will have been achieved:

1. Awareness created on the opportunities offered by agricultural mechanization and SAM hire service provision and on how a farm mechanization service enterprise operates.
2. Understanding by tractor owners and MSPs on the role of CA in curbing environmental degradation and declining agricultural productivity, and in making farmers competitive and enabling them to demand for more and affordable SAM hire services.
3. Identify SAM opportunities in the local area and facilitate linkages to machinery, financial products and access to information & technologies.
4. Ability to select appropriate equipment according to desired technical and financial criteria.
5. Practical information sharing, networking and partnership modalities amongst tractor owners and operators initiated and enhanced.

3.4. Course Target Audience

The target audience of this are mechanization service providers at two levels. The first level is that of machinery operators. At the second level are managers or owners of the machinery with potential of advancing the mechanization service provision agenda. They include private machinery owners, farmer or MSP cooperatives and machinery dealers. Machinery operators are expected to have basic primary school education with ability to read and write. Machinery owners/managers are expected to have secondary schools' education, owning a smart phone and with ability to access and use internet platforms.

Course content

The course is designed to cover a range of topics organized in 6 modules. Each module includes - learning activities and/or exercises, review questions and comprehensive sets of reference materials for further reading. Thus, the course will enable the participants to acquire adequate knowledge of SAM hire service as a business enterprise as well as on Conservation Agriculture. The course will encompass the following modules:

- Module 1: Introduction to hire services as a business enterprise
- Module 2: Introduction to Conservation Agriculture
- Module 3: Understanding the local production environment and market
- Module 4: Selecting appropriate machinery: technical and financial aspects
- Module 5: Operation and maintenance of agricultural equipment for hire service businesses
- Module 6: Managing the hire service as a business – including digitalization in supporting the management of operations of the hire service business.

3.5. Course Training Process

Prior preparation is key to the success of the course. The interactive nature of the learning exercises requires the trainer to be well prepared and it is important to read and be familiar with the recommended source materials such as “Hire Services as a Business Enterprise”, “Training Manual for Small-Scale Mechanization Service Providers”, well in advance of the training programme. The Trainer is expected to present the material, lead discussions and facilitate online/classroom and field exercises. The training process includes field exercises; participants report on the lessons learned in the field during the subsequent training session. This dynamic process encourages horizontal/peer learning, in addition to input from the facilitator, making the training content more relevant.

A sample of a one-day online training programme for investors - implying machinery owners, managers or offtakers - is presented in Annex 2. On the other hand, a sample three-day programme of machinery operators is presented in Annex 3.

4 TRAINING MODULES — SAM HIRE SERVICES AS A BUSINESS ENTERPRISE





MODULE 1: INTRODUCTION TO HIRE SERVICES AS A BUSINESS ENTERPRISE

4.1.1. Introduction

This module provides an introduction to and an overview of a hire service as a business enterprise. The foci of the training are on the commercial sustainability of the enterprises providing mechanization services to farmers including the small scale ones. It also introduces sustainable agricultural mechanization: a vital input for smallholder farmers in the context of sustainable crop intensification, and in particular CA.

Learning objectives



At the end of the module the learner /trainee should be able to:

- Explain the role and importance of hire services in the provision of smallholder farm mechanization inputs.
- Define and describe a hire service business.
- Understand basic records keeping and costings
- Explain the importance of protecting the natural environment while running a hire service business.
- List the advantages and benefits of mechanization for smallholders.
- Describe the importance of mechanization in the agrifood chain.

Materials



Flip charts, marker pens, Handouts (1.1 & 1.2), assorted videos, poster (the 3 principles of CA) and PowerPoint presentation

Training Methodology



- Facilitation (group discussion, plenary presentation)
- Demonstrations, charts, visual aids /posters
- Case studies /Exercises

Duration:



1.5 hours

4.1.2. Key concepts and discussions points

Introduce to the learners the following key concepts and discussion points as you lead the training. Open up for discussion as much as possible and ask as many questions as you can.

These key concepts and discussion points necessary to introduce the module and enhance the understanding of the participants in the subject matter are as follows:

Hire service as a business?

A hire service is a business that provides services for crop production, harvesting, post-harvest operations, processing, transportation and marketing. If one decides to run a hire service as a business enterprise, he/she must be prepared to: conduct business for profit; organize the business (type of business etc.); manage the business (management); develop good relations with customers and clients, forging business partnerships (who to join up with); find ways to make money (business model); provide services to customers (farmers, people needing transport etc.); and do business and make profits while protecting the natural environment (sustainable crop production).

Managing a hire service business

Most hire services are owned and managed by the same person. Managing a hire service business means looking after a hire service from a business perspective. It is a process of ensuring that activities and tasks are completed effectively and efficiently. This means doing the right things (effectiveness) and doing things right (efficiency), for example conducting the transport service on time, at a reasonable cost and for a fair price (doing things right). To be effective and efficient, the transport service must be planned, organized, coordinated, led, implemented and controlled properly. Indeed, the main skills required to manage a hire service are planning, organizing, coordinating, leading, implementing and controlling.

A **service** involves the provision of work activities that offer benefits without transfer of ownership. A service is usually **rented** (based on time spent). A hire service offers services, ranging from land clearance and soil tillage to processing and transport for marketing operations. It uses physical objects, such as a tractor, trucks and associated equipment, to provide services.

Sustainable Agricultural Mechanization for Sustainable Crop Production Intensification

The focus is on sustainable agricultural mechanization (SAM) in the context of sustainable crop production intensification. The emphasis is contextualized hire services as business with a view to employ sustainable natural resource management practices in the long term in order to enhance production and productivity for smallholder farmers and ensure profitability.

a). Sustainable agricultural mechanization (SAM)

SAM involves the application of different power sources (human muscles, draught animals and engines). Power sources are used in conjunction with appropriate tools, implements and machines to perform useful work in agricultural production and the subsequent agrifood chain. Sustainable agricultural mechanization must: meet farmers' needs efficiently and effectively; result in improved farm productivity and reduced drudgery; contribute to the development of the agrifood system (from production, through harvesting and processing, to marketing operations).

SAM takes fully into account environmental, economic, social, cultural and institutional issues and the protection of natural resources (especially soil and water).

b). **Conservation Agriculture (CA)**

Conservation Agriculture is defined as an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. It is characterized by three linked principles, namely:

Principle 1 **Minimum soil disturbance** to protect the soil from erosive and degrading influences and to encourage the healthy development of soil biota (fungi, flora and fauna). In practice, this means direct sowing and planting.

Principle 2 **Maintaining permanent organic cover on the soil surface** to protect the soil from erosive forces and to encourage improvements in soil carbon content and soil fertility. In practice, this means conserving crop residues in situ and establishing cover crops to keep the soil covered for as long as possible.

Principle 3 Maintaining a regime of **crop rotations, associations and sequences**, incorporating in particular the introduction of leguminous species.

More contents on CA are further discussed under module 2.

c). **Implements available for sustainable agricultural mechanization**

In smallholder CA, the principal mechanization requirements are for no-till seeding and weed control. CA aims for minimum soil disturbance, during both planting and weed control. In addition, implements are commonly required for irrigation, transport and processing. Equipment is available for the full range of power sources, from human and animal muscle power to two- and four-wheeled tractors (2WT and 4WT). Details of this is further discussed under module 2

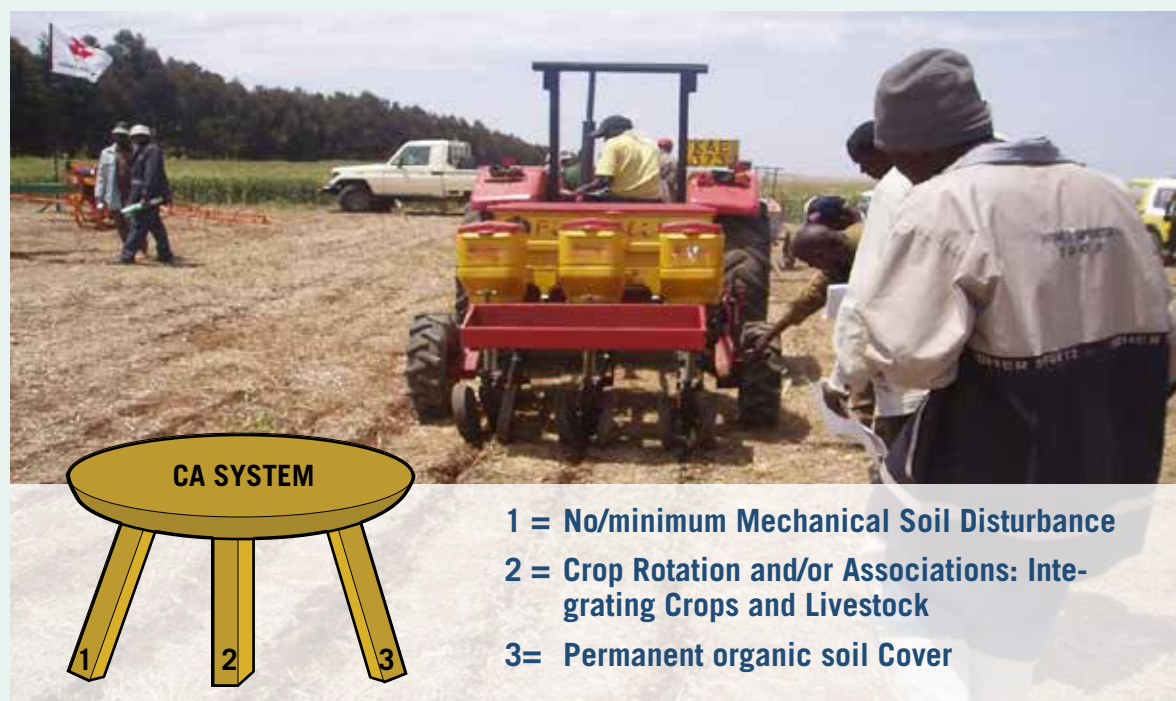


Figure 1: Pillars that Sustain the CA System



4.1.3. Learning activities and/or exercises

Learning Exercise 1.1: Enhance participants understanding on Farm Mechanization

Objective:

To introduce to the participants, the overall concept of mechanization and better their understanding of the potential solutions that mechanization can provide in the agrifood chain.

Materials required:

Video screen and player (or laptop, projector and screen), selected videos, pens and notebooks

Method:

1. Assemble the participants accordingly
2. Provide each participant with a pen and a notebook
3. Play the following videos and after each video, foster discussion, underlining the main messages of the video while encouraging participants to share their own views and experiences.
 - Video 1: (Duration 10.56): The foundations of wealth: Mechanization. Available at: <https://www.youtube.com/watch?v=dMOreKTruQk>
 - Video 2: (Duration 5.05): Powering smallholder agriculture in eastern and southern Africa. Available at: <https://www.youtube.com/watch?v=oe8J2ee4rAU>.
 - Video 3: (Duration 13.58): Maize mechanization for production and postproduction in the Philippines. Available at: <https://www.youtube.com/watch?v=kgpWtPmT6Qc>
4. Ask participants to identify the main points and discuss the following questions:
 - What are the advantages of mechanization?
 - What are the benefits of mechanization in eastern and southern Africa?
 - What are the benefits of mechanization in countries with high levels of adoption such as Brazil or Canada?
5. Summarize the discussion notes for each of the issues above.

Learning Exercise 1.1: Exchange of knowledge and experience on hire service as a business

Objective:

To capture the understanding of hire service as a business concept according to the participants

Materials required:

Flip charts, marker pens and handouts 1.1 – why a hire service as a business

Method:

1. Break the participants into groups
2. Provide each group with marker pen and flip charts
3. Assign each group to discuss the following issues using the handout in a question-posing mode, allowing participants to discuss and discover what they represent. The agreed responses should be captured in flip chart for plenary presentation: Ask participants
 - To describe what is a service in their understanding
 - To describe what is a hire service as a business
 - To indicate why should hire service be managed as business,
 - To describe / list the challenges of implementing mechanization service provision as a business.
4. Afterwards, each group will present to the plenary for discussion
5. Summarize the discussion notes as the participants understanding and experience in hire service provision and business.

Learning Exercise 1.3: Expose the participants to the concepts and principles of CA

Objective:

To introduce to the participants, the concept and principles of Conservation Agriculture

Materials required:

Video screen and player (or laptop and projector with screen), selected videos, pens and notebooks

Method:

1. Assemble the participants accordingly
2. Provide each participant with a pen and a notebook
3. Play one or two from the following videos and after each video, foster discussion, underlining the main messages of the video while encouraging participants to share their own views and experiences.
 - Video 2: Introduce video 1 (duration 7.11): *Conservation Agriculture*. Available at: <https://www.youtube.com/watch?v=VW-suSow738g>.
 - Video 2: Introduce video 2 (duration 12.05): *Conservation Agriculture versus traditional agricultural techniques*. Available at: <https://www.youtube.com/watch?v=nbOXwXeqKvg>.
 - Video 3: Introduce video 3 (duration 13.56): *Exchanging experiences in Conservation Agriculture*. Available at: <https://www.youtube.com/watch?v=5IjkRIn7KTY>.
4. Ask participants to identify the main points and discuss the following questions:
 - What is Conservation Agriculture and why?
 - What are the principles of CA and how are they applied?
 - Why is it important to farm in an environmentally friendly way?
 - What are the differences between CA and traditional agriculture?
 - Why is it important to exchange experiences on Conservation Agriculture?
5. Summarize the discussion notes for each of the issues above.

4.1.4. Review questions

- a). What is a hire service as a business?
- b). How do you define a hire service?
- c). What does managing a hire service mean?
- d). List down the duties and responsibilities of the owner/manager in managing hire service as a business
- e). Why is it important to do business in an environmentally friendly way?
- f). What are the benefits of mechanization?
- g). What is Conservation Agriculture and why?
- h). What are the principles of CA and how are they applied?
- i). Why is it important to farm in an environmentally friendly way?
- j). What are the differences between CA and traditional agriculture?
- k). Why is it important to exchange experiences on Conservation Agriculture?

4.1.5. Sources of additional/further reading/reference materials

Recommended background reading: Share with participants any readings you feel may be relevant and useful. The publications listed below are freely available online

- FAO. 2016. *Agricultural mechanization: a key input for sub-Saharan African smallholders*. Rome. Available at: www.fao.org/3/a-i6044e.pdf
- FAO. 2012. *Hire services by farmers for farmers*. B. Sims, A. Rottger & S. Mkomwa. Rome. Available at: <http://www.fao.org/3/a-i2475e.pdf>.
- [Agricultural Mechanization Strategies, and Agricultural Mechanization Policies for Eastern and Southern Africa countries](#)
- FAO. 2009. *Rural transport and traction enterprises for improved livelihoods*. Rome. In particular, pp 1–45. Available at: www.fao.org/3/a-i0525e.pdf
- FAO. 2011. *Save and Grow. A policymaker's guide to the sustainable intensification of smallholder crop production*. Rome. 102 pp. Available at: <http://www.fao.org/docrep/014/i2215e/i2215e.pdf>.
- FAO. 2013. *Save and Grow. Cassava: A guide to sustainable production intensification*. Rome. 129 pp. Available at: http://www.fao.org/ag/save-and-grow/cassava/index_en.html.
- FAO. 2016. *Save and Grow in practice: Maize, rice, wheat. A guide to sustainable cereal production*. Rome. 110 pp. Available at: <http://www.fao.org/publications/save-and-grow/maize-rice-wheat/en/>.

Recommended websites and videos: Share with participants any links you feel may be useful and integrate into exercises in the relevant sessions. Note that the list is subject to updating as new, more appropriate materials become available. The links below are freely available online:

- FAO. 2018. Sustainable agricultural mechanization. FAO website. Available at: www.fao.org/sustainable-agricultural-mechanization/en
- Video (duration 14.24). Agricultural mechanization for small scale farmers in Uganda. Available at: <https://www.youtube.com/watch?v=PmdjhLkLIKk>.
- Video (duration 3.21). Benefits of farm mechanization. Available at: <https://www.youtube.com/watch?v=Oij583UZdfo>
- Video (duration 21.06). Farm mechanization in India. Available at: <https://www.youtube.com/watch?v=NAE2kui8RUA>.
- Video (duration 14.25). *Conservation Agriculture in Zambia*. Available at: <https://www.youtube.com/watch?v=qRh6FCvx9Ig>.
- Video (duration 15.00). *Conservation Agriculture in the Philippines*. Available at: https://www.youtube.com/watch?v=Vc_AtfaP-EA.



MODULE 2: INTRODUCTION TO CONSERVATION AGRICULTURE

4.2.1. Introduction

This module explains the concept “Conservation Agriculture” and discusses the detrimental impact of conventional agricultural practices like ploughing and harrowing. And the additional activities like leaving the bare soil covered with either dead (crop residues) or living (crop rotation) mulch.

Learning objectives	
	<p>At the end of the module the learner /trainee should be able to:</p> <ul style="list-style-type: none">• Explain the role and importance of CA in the production of crops• Mention the three principles of CA.• Understand the impact of conventional agricultural practices on the environment.• List the advantages and benefits of CA for smallholders.
Materials	
	<p>Flip charts, marker pens, Exercise 1, assorted videos, poster (the 3 principles of CA) and PowerPoint presentation</p>
Training Methodology	
	<ul style="list-style-type: none">• Facilitation (group discussion, plenary presentation)• Demonstrations, charts, visual aids /posters• Exercises
Duration:	
	<p>2.5 hours</p>

4.2.2. Key concepts and discussions points

Before starting a hire service business, it is good to have a general understanding of the environment. Start by facilitating a plenary group discussion to answer the question: what are the short-term and long-term effects of ploughing-based conventional tillage systems? Probe to seek mention or stakeholder understanding of the points in the below matrix.

Short-term effects of ploughing	Long-term effects of tillage-based systems
Weeds are controlled	Depleted soil organic matter
Seedbed is prepared	Damaged soil structure and macro pores
Water infiltration improves	Soil flora and fauna disappear
Soil aeration improves	Hard/plough pan formation
Nutrients are released, availed	Acute soil water availability and restricted aeration
Incorporation of manure, fertilizers and organic matter	Distortion of pH levels
Loose soil eroded and nutrients are leached	Decline in nutrient availability

While tillage-based land preparation activities are highlighted, there are other supportive climate smart practices that compliment land preparation activities. These include soil and water conservation structures, agroforestry, improved fallows with shrubs, fallow trees, soil cover crops and boundary tree lines for wind breaking.

The trainer/facilitator should link the alternatives to the unsustainable conventional tillage systems to CA-based systems with a small video of the Tanzanian farmer who has improved his land and is making a living: <https://www.youtube.com/watch?v=l0orM79a6oo>

Watch small video on how plants grow:

<https://www.youtube.com/watch?v=w77zPAtVTul>

For plant roots to be able to extend and grow to penetrate and explore the soil for nutrients and water, the soil needs to have certain characteristics:

- not too dense – the roots need to explore the soil and when the soil is hard or very compacted it will need a lot of energy to get water and nutrients.
- not too wet – roots need also oxygen to breath and in soils that are too wet, they will suffocate
- enough nutrients, which they can obtain through a symbiosis with soil life
- but most important of all: soil life: the nutrients plants need to grow well are provided to them by micro-organisms that live in the soil. They act as a kind of messenger between the nutrients and the roots.

Ideally half of the soil is made up of sand, silt and clay, the other half exists of pores filled with water and air and soil life. This soil life is important to supply plants with water and nutrients. Soil food web explained 5:56 min.

<https://www.youtube.com/watch?v=uAMniWJm2vo>

On nutrient cycling, 3:12

<https://www.youtube.com/watch?v=NVhY4ssMtbl>

Contrary to what people believe, soil tillage will result in the loss of pore space and thus oxygen, which is needed for root growth and bacteria and fungi that provide nutrients to the plants. At first a lot of oxygen is ploughed in, which will make the bacteria and fungi that decompose organic matter very happy, leading to a rapid turnover of the available nutrients. In a field that does not have a lot of living roots yet that can take up the nutrients, these nutrients are easily lost for the next crop with subsequent rains.

These beneficial organisms only live where there is enough oxygen. With less oxygen in the soil, more problems with disease will occur because disease-causing organisms usually prefer less oxygen in their living environment. Now we know this, we return to CA.

Conservation Agriculture is any form of agriculture that lends itself to the preservation of the soil life. This can be done by applying three fundamental principles:

- No mechanical soil disturbance or zero tillage
- Permanent soil cover
- Crop rotation

To be able to have a maximum soil cover, burning crop residues should not be part of land preparation.

Conservation Agriculture systems are systems that utilize soils and crops with the aim to reduce the excessive mixing-up of the soil and maintain the crop residues on the soil surface in order to minimize damage to the environment.

In this way, it will:

- provide and maintain an optimum condition of the root-zone to maximum possible depth for crop roots to function most effectively and without hindrance, in capturing high amounts of desired plant nutrients and water.
- ensure that water enters the soil so that (a) plants never, or for the shortest time possible, suffer water stress that will limit the expression of their potential growth; and so that (b) residual water passes down to groundwater and streamflow, not over the surface as runoff.
- favour beneficial biological activity in the soil in order to (a) maintain and rebuild soil architecture; (b) compete with potential in-soil pathogens; (c) contribute to soil organic matter and various grades of humus; (d) contribute to capture, retention, chelation and slow release of plant nutrients.

No mechanical soil disturbance or zero tillage

Direct seeding involves growing crops without mechanical seedbed preparation or soil disturbance since the harvest of the previous crop. The term direct seeding is used synonymously with no-till farming, zero tillage, no-tillage, direct drilling, etc. No-tillage involves slashing the weeds and previous crop residues or spraying herbicides for weed control, and seeding directly through the mulch. All crop residues are retained, and fertilizer and amendments are either broadcast on the soil surface or applied during seeding.

Effects:

- minimal destruction of soil structure through pulverisation, compaction and/or plough pan development
- slower mineralization of soil organic matter through less exposure to climatic elements and soil micro- and macrofauna
- no disturbance of worms and other soil inhabitants, maintained soil biodiversity and balanced activity and food web in the soil including natural predation
- no breaking of roots
- better infiltration and circulation of air and water into and through the soil profile through maintained biopores and vegetative cover and optimal rooting
- reduced evaporation from bare soil surfaces
- soil regeneration rate through mineralization and decomposition and re-structuring higher than soil degradation through loss of porosity and soil particles (erosion) and loss of plant nutrients (fertility)
- improved nutrient retention and availability for plant growth and reduced leaching of nitrogen and other nutrients

Means and practices:

- no ploughing, subsoiling, harrowing
- use of direct seeding through crop residues
- no incorporation of crop residues into the soil
- permanent bed planting
- use of crop rotations, balanced biodiversity and pesticides for weed/pest control instead of ploughing or using high rates of chemicals that endanger soil life and disturb the soil web and ecological processes including the hydrological cycle and water quality

Permanent soil cover

A permanent soil cover is important to:

- protect the soil against the impact of rain and sun,
- provide the micro and macro organisms in the soil with a constant supply of “food”, and
- alter the microclimate in the soil for optimal growth and development of soil organisms, including plant roots.

Effects:

- improved infiltration and retention of soil moisture resulting in less severe, less prolonged crop water stress and increased availability of plant nutrients
- source of food, habitat and energy for diverse soil life: creation of channels for air and water, biological tillage and substrate for biological activity through the recycling of organic matter and plant nutrients
- increased humus formation
- reduction of impact of rain drops on soil surface resulting in reduced crusting and surface sealing
- consequential reduction of runoff and erosion
- soil regeneration is higher than soil degradation
- mitigation of temperature variations on and in the soil
- better conditions for the development of roots and seedling growth

Means and practices:

- use of appropriate/improved seeds for high yields as well as high residue production and good root development
- integrated management and reduced competition with livestock or other uses e.g. through increased forage and fodder crops in the rotation
- use of various cover crops, especially multi-purpose crops, like nitrogen-fixing, soil-porosity-restoring, pest killers, etc.
- optimization of crop rotations in spatial, timing and economic terms
- targeted use of herbicides for controlling cover crop and weed development

Crop rotation

If we want to optimize the functioning of the beneficial soil life, it is necessary to have living roots in the field for as long as possible. Rotation of crops is not only necessary to offer a diverse “diet” to the soil microorganisms, but as they are rooting at different soil depths, they are capable of exploring the different soil layers for nutrients. Nutrients that have been leached to deeper layers and that are no longer available for the commercial crop, can be “recycled” by the crops in rotation. This way the rotation crops function as biological pumps. Furthermore, a diversity of crops in rotation leads to a diverse soil flora and fauna, as the roots excrete different organic substances that attract different types of bacteria and fungi, which in turn, play an important role in the transformation of these substances into plant available nutrients.

Effects:

- higher diversity in plant production and thus in human and livestock nutrition
- reduction and reduced risk of pest and weed infestations
- greater distribution of channels or biopores created by diverse roots (various form, size and depths)
- better distribution of water and nutrients through the soil profile
- exploration for nutrients and water of the whole soil profile by roots of many different plant species resulting in an optimal use of the available nutrients and water
- increased nitrogen fixation through certain plant-soil biota symbionts and improved balance of N/P/K from both organic and mineral sources
- increased humus formation

Means and practices:

- design and implementation of crop rotations according to the various objectives: food and fodder production (grain, leaf, stalks), residue production, pest and weed control, nutrient uptake and biological subsurface mixing/cultivation, etc.
- use of appropriate/improved seeds for high yields as well as high residue production of above-ground and below-ground parts, given the soil and climate conditions

4.2.3. Learning activities and/or exercises

Exercise 1: Enhance participants' understanding on relations between soil related issues and human interventions

Objective:

To introduce to the participants, the relationship that exists between environmental issues, such as soil erosion or low soil fertility, and human interventions, like intensive soil tillage, and improve their understanding of the potential that Conservation Agriculture can provide in the production of food.

Materials required:

Sticky notes with the words copied from the table on the exercise sheet. Flip chart or wall to stick the notes to, to visualize their relationship.

Method:

Explain the concept of cause-effect tree. Show the examples from the exercise sheet. Discuss and make sure that cause and effect relations are clear. Sometimes actions promoted by extension staff are aimed at combating the symptoms of a problem, for instance erosion control, without looking at the real cause, which is loss of soil life (which of course requires a different approach all together).

Duration: 1 hr.

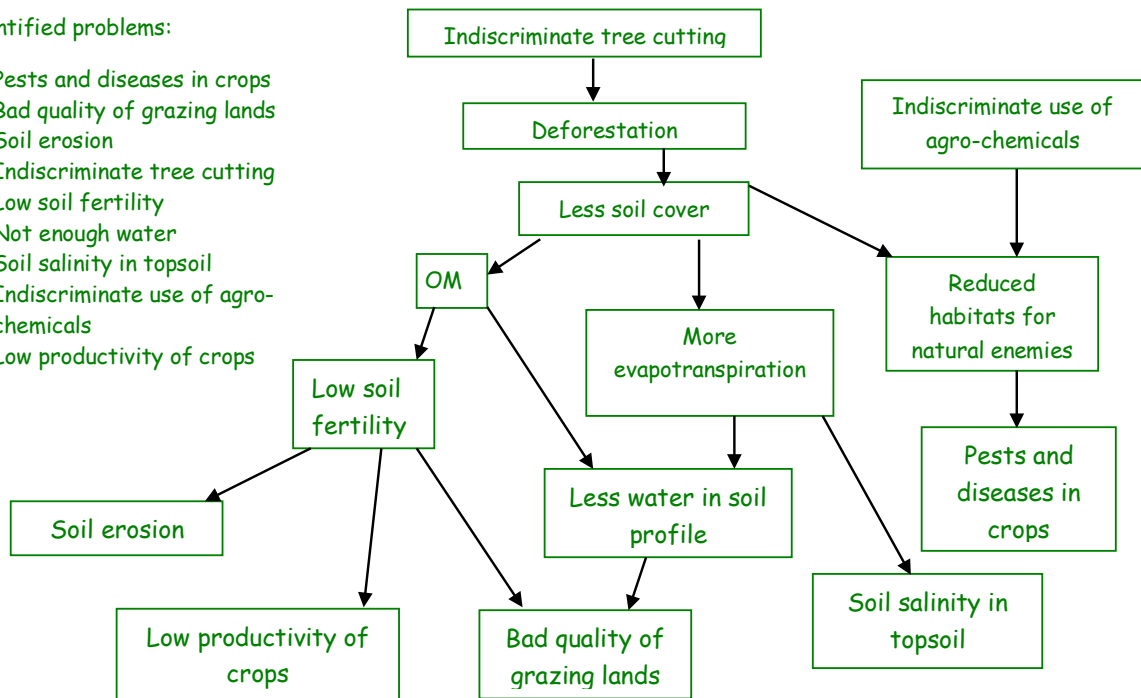
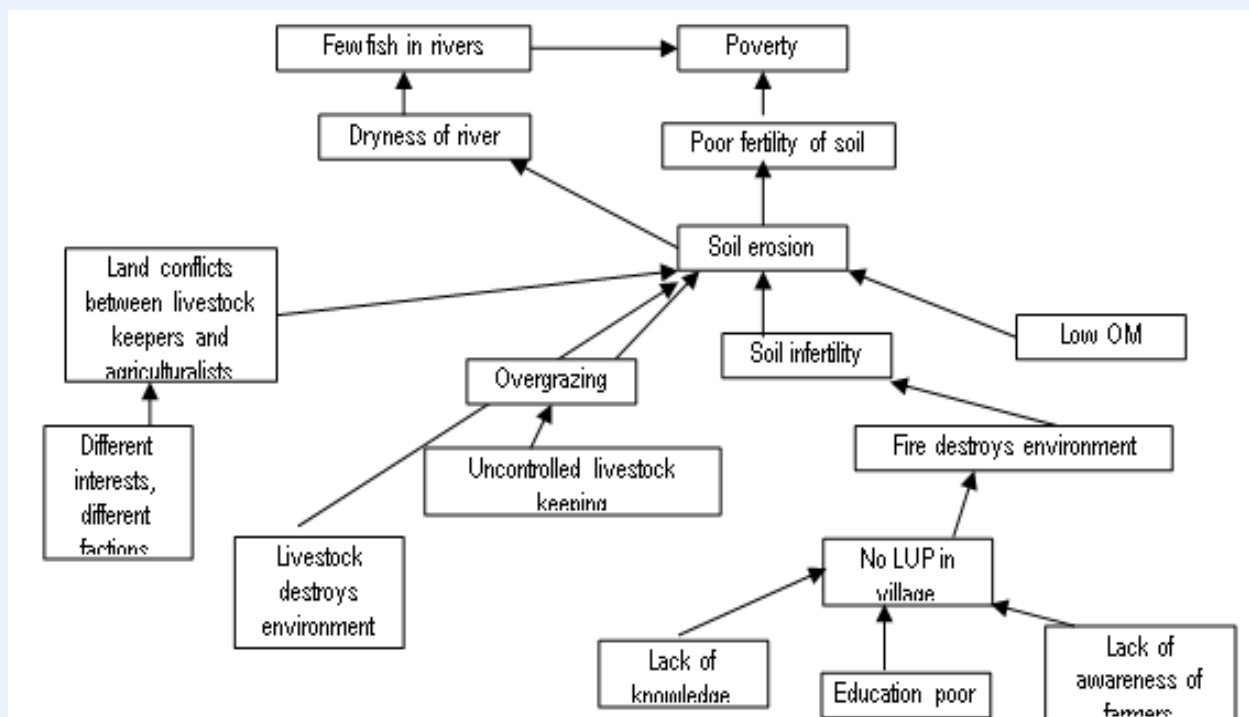
Allow for an hour total discussion and understanding. This is important because this explains the importance of the actions to be taken in Conservation Agriculture.

Exercise 1: Soil related cause-effect tree

Box 2 Cause-Effect Relationship of identified problems

Identified problems:

- Pests and diseases in crops
- Bad quality of grazing lands
- Soil erosion
- Indiscriminate tree cutting
- Low soil fertility
- Not enough water
- Soil salinity in topsoil
- Indiscriminate use of agro-chemicals
- Low productivity of crops



These are examples of problem trees in which soil related problems are organized in such a way that one has an effect on the other. These examples are taken from a real life situation in Tanzania, where these problems were brought up by a group of farmers and extension staff. The same can be done for CA related issues.

As one person put it to explain to the rest how the challenges can become less problematic when you organize them this way:

“If you cut the roots of the tree, the tree is going to dry”.

Eventually, challenges with more easy to find solutions will surface. Sometimes this makes it easier to deal with bigger problems. By solving the smaller problems, the overall bigger challenge can be tackled. But this works only when people understand the relation between the sub problems.

This exercise also works to get an understanding of the impact of certain activities.

Exercise: Create a logic cause-effect tree with the given words

For the trainer:

Copy the words of the list in the table to sticky notes (one on each) and divide them among the participants of the training session. Make sure that everyone understands what is written on his/her note. Invite one by one the participants to stick their note on a flip chart or wall in such a way that a relationship emerges between the terms. Invite them to, while positioning their note, argument on the reason for them to do so.

List of words for the cause-effect tree		
Disc ploughing	Air pollution	Poor people
Stubble burning	Water pollution	Less trees and shrubs
Bare soil	Loss of wild animals	Soil compaction
Loss of soil fertility	More pests/diseases in crops	Fewer plant species in the field
Soil erosion	‘Hard’ soils	Low rainfall
Dust storms	No water infiltration	Less water available for crops
Infertile soils	Low yields	Water reservoirs dried up

Then analyse the ‘tree’ and see what the effects are of ploughing and when you stop ploughing (remove the sticky note from the wall and the notes that are effected by tillage) what will be the effect of that. Discuss with the participants.

Exercise 2: Simulation of a rain shower creating run off

A totally tilled and harrowed field contains very fine soil particles that are easily eroded. When the soil surface is protected by a cover (either dead mulch or living cover crops) the soil will stay in the field and be preserved for crop growth.

Objective:

By the end of this activity, students should be able to:

- explain that erosion is the wearing away of soil by water
- understand the effect of intensive tillage
- explain why protection of the soil with a cover is important

This demonstration simulates rain falling on a field, either ploughed/tilled or protected with soil cover.

After working with this water run-off and soil erosion model and a range of simulations, students should understand that:

- one cause of erosion is the removal of soil by water
- gravity pulls the water down the hill
- a steeper angle will increase the rate of water flow, resulting in more erosion
- vegetation provides resistance, intercepting raindrops and slowing the rate with which they hit and penetrate the soil
- plant roots help to hold the soil together and slow the rate at which soil erodes
- vegetation reduces erosion and increases the stability of the ground.

Materials:

- 3 plastic bottles of the same size (2 litre bottles work well)
- Soil (enough to fill bottles)
- 3 clear cups/ small soda bottles in half
- 3 pieces of wire or cords
- Cups or blocks to support your bottles
- Scissors or utility knife (utility knife works better)
- Mulch
- Sprinkling-style watering can, spray bottle, or rain simulator
- Grass seed or sod
- Tape (or other materials to build your supports)

Method:

Cut off one side of each bottle. Fill with soil (if you intend on growing grass, plant grass in one bottle now and wait for it to sprout). Add mulch or dead leaf cover to one of the non-grass bottles, leave the last bottle of soil bare. Suspend the bottles over the 3 cups at a 25 to 40-degree angle with the spouts facing downward. Get creative in finding ways to accomplish this. How they're held is unimportant as long as they're angled. Run water over the top of the soil in each bottle. (If your soil hasn't had time to settle, you should discard the first few centimetres from each cup.) Use your rain simulator (or watering can) to apply equal amounts of water to each bottle.

			
Cut off each bottle and fill with soil	Apply mulch and seeds	Fix wire to the cups or half bottles and attach to each spout	Gently apply water and watch the runoff and water colour

Discussion questions:

Before applying the water, have student guess what the water will look like in the cups. Have the students compare the differences in the clarity (and turbidity) of the water in each cup. Have the students make observations of the soil surface before, during and after the “rainfall event”

- How does rainfall increase the likelihood of erosion?
- What difference does the steepness of a slope make to the rate of water flow and erosion?
- How does vegetation help to prevent soil erosion?
- What are some potential effects when vegetation is removed either through deforestation or wild fire?

Duration: 15 minutes.

All the material should already be prepared beforehand, so no time is spent in setting up the experiment.

To give an idea what it should look like: <https://www.youtube.com/watch?v=im4HVXMGI68>

Rainfall simulator with bare soil, and covered soil:

<https://www.youtube.com/watch?v=5Xv6GRcZwgg>

4.2.4. Sources of additional/further viewing/reference materials

ARC About Conservation Agriculture Part 3, 4:22 min.:

<https://www.youtube.com/watch?v=2EBIcA3VO4s>

Namibia Specific Conservation Agriculture - Conservation Agriculture Namibia (C.A.N.)

<https://www.youtube.com/watch?v=IGqwmHoqwXA>

Conservation Agriculture in Malawi <https://www.youtube.com/watch?v=HvjAXTe5Ec4>

Lydia Kamba, a Conservation Agriculture farmer in Kenya, 5:00 min

<https://www.youtube.com/watch?v=ltW-0D7QG0>

Farm Mechanization using Two Wheel Tractors in Arumeru and Mbulu District Tanzania: 13:52 min.

<https://www.youtube.com/watch?v=KRfO-chRD3w>

Farm Mechanization and Conservation Agriculture Kenya Video, 13:13 min.

<https://www.youtube.com/watch?v=togiZfnfsnk>

Agricultural Mechanization for Small Scale Farmers in Uganda I, 14:24 min

<https://www.youtube.com/watch?v=PmdjhLkLIKk>



MODULE 3: UNDERSTANDING THE LOCAL PRODUCTION ENVIRONMENT AND MARKET

4.3.1. Introduction

A hire service business is a potentially profitable enterprise if owners or managers are familiar with their surrounding area, the whereabouts of existing and potential customers and the location of support services. It is important to assess the demand both prevailing and prospective; to know which hire services to offer and what prices to charge to make the business profitable. Knowledge of the support services available in the neighbourhood is required for the business to operate effectively and efficiently.

The module provides an overview of the importance of a local area and market assessment. The module provides a practical, simple and easy-to-use assessment method to enable the owners/managers of hire service businesses to better understand the local context in which they work, or intend to work. Understanding the market entails identifying potential customers, setting prices for services offered and understanding the competitive environment.

An assessment of the local area and market aims at appreciating the potential market for any service offered and to understand what services are available to support the mechanization provision business efficiently and profitably.

Learning objectives



- Describe what a local area and market assessment involves.
- Understand the importance of local area and market assessment for a hire service business.
- Understand how to carry out a local area and market assessment.
- Describe a support service assessment and explain why it is important.
- Understand how to carry out a support service assessment.

At the end of the module the learner /trainee should be able to:

- Acquire the skills to identify potential production systems as well customers and assess the services in highest demand.
- Identify what types of support services are needed and available locally.
- Identify financial organizations that can provide credit in the vicinity.
- Identify other support services providers and the type and quality of services they provide in the local area to make them competitive in the hire service business.
- Understand the steps involved in the assessment process and demonstrate how to carry this out.

Materials	
	Laptops, overhead projectors; power point projectors, handouts, posters, fact sheets, training manual, flip charts, writing pads, note books, pens, pencils, masking tape and marker pens.
Training Methodology	
	<ul style="list-style-type: none"> • Facilitation (plenary presentation by facilitator, group discussion, plenary presentation and discussion of group work) • Demonstrations, charts, visual aids /posters • Exercises
Duration:	
	1.5 hours

4.3.2. Key concepts and discussion points

Local Area and Market Assessment

It is a process that involves investigating production systems, markets and support services to discover potential business opportunities for the hire service provider; and to identify the support services needed to operate as a business in a certain locality.

Why is it Important?

For the hire service business to have a chance of success, you need to be aware of opportunities in the local market and to understand what support service providers your business might need to operate cost effectively and competitively.

The local area and market assessment enables the service provider:

- To know the locality, production systems and the agroecology of the area within which the hire service provider intends to run his/her business. It enables him to know the topography, soils, cropping pattern, farm sizes and what type of crops produced which assists him in the selection of appropriate machinery for use in the area.
- To assess the demand for hire services both prevailing and prospective;
- To know which hire services to offer and what prices to charge to make the business profitable and competitive.
- To assess the feeder road conditions and accessibility of the machinery to the farms.
- Continual assessment is also important as new opportunities might arise and the service provider has to be ready to take advantage of them to keep the hire service business in operation and profitable.

The local area and market assessment involves:

- Observation of local farms (soil types/conditions, topography, what is grown/reared, farm size, cropping patterns etc.)
- Interviews with farmers to find out what mechanization services may be needed, when they need them and what prices they are willing to pay.

- To know what support services are available in the area to enable the hire service business to operate effectively.
- Research into eventual competition, the services offered and at what prices.

Thus an assessment may require visits to farms; apart from discussions with respondents. Physical individual observations of the locality should be made to complement the information provided on the checklist.

However, before preparing the assessment process, you must specify what services you can offer with your hire service based on your business assets which for example they may include a 75 Hp tractor, a ripper, a trailer, and a maize sheller or you might have a combination of a two-wheel tractor, a seeder and a transport trailer.

Conducting a Market Assessment

The market assessment process involves the following steps:

STEP I: Decide what Market Information is needed

The most important questions for a hire service provider in collecting the needed market information are: **Who, why, what, when, what kind** and **how much**;

- **Who** - A hire business needs to identify its potential consumers, who can be farmers, traders, processors, local construction companies, local municipalities or people needing transport.
- **Why** – Understand the customers’ needs. It is crucial to know why they require hire services. Potential customers will buy services to fulfil their particular needs; and different customers have different needs.
- **What** – It is essential to identify the specific types of services required. Types of services potentially required may include tillage/ripping, planting seeds (crops), water pumping, harvesting, drying, processing and transport.
- **When** - Understanding when to provide services (timing) is critical, as demands for services may occur at the same time of the year. When resources are limited, choose the most profitable activity.
- **What kind**. Providing the right kind of service is crucial, as customers need to know that the business is not only reliable, but it provides a quality service that the customer needs.
- **How much**. Pricing of services is one of the most important aspects of a hire service business. The prices charged for services determine the profits of the hire service business and also can determine the volume of the business when prices are attractive to customers.

Other market information which may also be important include:

- What other new services can be provided or where the most profitable services can be sold.
- How severe is the competition?
- How many other businesses provide similar services?
- What quality of service do competitors offer?



Project: Promoting Agricultural Mechanization Hire Services as a Business Enterprise
Activity: Training of Mechanization Hire Services Providers

STEP 2: Consider where the Market Information can be found

Once the information objectives are established, identify where information can be found. To understand customer needs, ask questions directly to potential consumers, farmers and traders. Visual observation is also useful for ascertaining farm size, what is produced on the farm, soil conditions, how water is used, how farm production is carried out etc.

STEP 3: Make a Plan to Collect the Market Information

Gather information methodically, following a plan. Decide who are to be interviewed; fix a time and place for the interviews; prepare the questions to be asked; establish how the information gathered will be recorded; fix a time for the duration of the interview and calculate the costs entailed.

STEP 4: Devise a Method for Recording the Market Information

Recording the information is essential. Write down all interview responses and visual observations as it might be difficult to remember all the information. Use note books and writing pads or mobile phones to record the information.

STEP 5: Analyse the Market Information Collected

Once collected and recorded, the information needs to be read, understood and carefully analysed. Interviews with traders and farmers etc. produce a lot of information. The provider needs to analyse the service options and identify the most profitable services in each season.

STEP 6: Prepare the Required Report

Analyse the collected data and write the report using the captured information. The report should be illustrated using graphs, tables, frequencies, etc.

Conducting Support Service Assessment

Why is it Important?

You need to know what support service providers exist in the area to provide the inputs and materials needed for the hire service business to operate cost effectively. A support service assessment helps understand the location of support services, who runs them, what services they can provide, when, at what price and what quality.

A support service assessment gathers information about customers (existing and potential) and the support services in the local area. The information can be used to identify potential customers (farmers, traders, processors etc.); understand local farming systems (farm sizes, cropping patterns etc.); understand the nature and fragility of local natural resources (soil types, water resources, forests etc.); understand customer needs and what they require (no-till seeding, water pumping, transport etc.); determine what prices to charge for services; understand the location and capacity of support service providers in the local area. This understanding will facilitate decision-making with regard to offering new services.

Support services include:

- Dealers - provide machinery, equipment and spare parts, as well as advice on operational and technical aspects; and they may also provide training.
- Manufacturers and Blacksmiths – fabricate machines, implements and tools

- Maintenance and repair services - mechanics, welders and blacksmiths.
- Fuel and Lubricants suppliers - of good quality and available regularly
- Extension Services – to provide technical advisory services and training
- Financial Institutions – to provide loans for procurement of machines or for operational costs
- Telecommunication services (mobile phone network) – simplify communications with customers and facilitate financial transactions.

There are three basic steps to performing a support service assessment:

- i. List the support services available, charges and operational issues.
- ii. Identify their location and determine whether they are easy to reach.
- iii. Interview support service providers to gain a sense of their capacities and gauge their ability to effectively support the hire service business.

Conducting an Assessment of Financial Sources

STEP 1 Decide What Information is needed to assess finance and credit organizations.

A hire service provider requires the following information:

- **Credit provider.** A hire business needs to identify who can potentially provide credit, for example, traders, processors, NGOs and banks, and where they are located.
- **Type of credit** – It is important to understand what types of credit are available in the local area. Medium and long term credits; leasing from a manufacturer or dealer.
- **Interest rates.** For each of the credit types available, it is important to understand what the interest rates are and how these are applied throughout the payback period.
- **Guarantees.** Credit usually requires the hire service business to provide a guarantee (assets or collateral). Guarantees are usually assets that can be easily converted into cash if they are sold.
- **Reliability.** Lenders (e.g. a trader, an NGO or a bank) need to be reliable: they provide credit according to agreed terms, within the prescribed time frame and do not change the terms and conditions.

STEP 2: Consider Where the Information can be found

Having established the objectives, identify where to find the information.

STEP 3: Make a Plan for Collecting the Information

Information collection must follow a plan. Decide which banks and other financial organizations are to be interviewed; identify where they can be found; specify who is to be interviewed; prepare the questions to ask; decide how to record the information collected; establish the duration of the interviews and calculate the cost.

STEP 4: Devise a Method for Recording the Information

Write down or record all interview responses and visual observations (using, for example, a mobile phone) as it may be difficult to remember all the information from the respondents.

STEP 5: Analyse the Information Collected

All the information from the interviews must be read and understood, and pertinent facts need to be absorbed to then carefully analyse the information collected. Use the analysed data to make correct decisions regarding credit.

Service Map and Service Delivery Plan

After carrying out the assessment; doing the analysis of the collected information; and establishing the local context and identifying the potential customers (what, who, where and when) and the main types of services required; the hire service provider should develop a Service Map and a Service Delivery Plan as a guide based on his business assets.

The main services required may include:

- Crop production services: ripping and planting.
- Plant protection and chemical weed management services.
- Transport of produce, crop by-products and building materials e.g. bricks.
- Harvesting services with reapers, combine harvesters
- Processing services: shelling, threshing, milling.
- Irrigation services: pumping water with power from the tractor engine.

Service Map

In order to plan his business better, it is useful for the service provider to arrange the gathered data or information in a “service map” to assist in the planning of timely and cost effective delivery of services. The Service Map will show the location of the village and farms; location of customers (existing and potential); position of support services providers including repair workshop, fuel and lubricants suppliers, machinery dealer, agro inputs dealer, bank etc.; main road system and the estimated distances to travel to the various localities.

Service Delivery Plan

Start by establishing first the schedule of the service requirements based on the cropping calendar. For example:

Ripping:	4 weeks, once per season
Planting services	3 weeks, once per season
Weeding:	2 weeks, twice per season
Paddy harvesting	4 weeks, once per season
Shelling and threshing:	3 weeks per season

Finally develop the Schedule Delivery Plan based on the Seasonal Activity Cropping Calendar taking into consideration the Schedule of the service requirement and the capacity of the machinery in the hire service business. [Draw up the Schedule Plan].

Service Delivery Plan for a Hire Service Provider in Kongwa District

Operation	Timing	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ripping	4 weeks/season												
Planting maize	3 weeks/season												
Puddling paddy	4 weeks/season												
Weeding	2 weeks 2/season												
Harvesting paddy	2 weeks/season												
Threshing paddy	2 weeks/season												
Shelling maize	2 weeks/season												
Transport produce	4 weeks/season												
Transport materials	one week/ month												

Notes: Planting by direct seeder or manual; Puddling by a rotavator; Weeding- herbicide application by knapsack or boom sprayer; Harvesting by reaper or combine harvester; threshing by motorized thresher

Cost of Service Delivery and Profitability

- Estimate the costs of offering the different services taking into consideration both fixed costs (such as depreciation of the machines, Interest, Insurance) and variable costs (the cost of fuel, maintenance and repairs for the machinery, and labour costs for operators).
- Calculate the Price for Service Delivery of each activity or operation the service provider intends to provide taking into consideration the Break-even Point and a Profit Mark Up (15-20% of the service delivery cost).
- Find out how much the people are willing to pay for the selected/intended services and compare them with the calculated Service Delivery Price to determine whether it is profitable to undertake the hire service business in the area.
- Go for the services if the calculated Service Delivery Price is lower than the Price which the people are willing to pay and decline to go into the intended hire service business if it is lower.
- Select the most profitable activities when there is time and machinery capacity limitation with the hire service business.

4.3.3. Learning exercises and review questions

- a) Describe what is a local area and market assessment?
- b) Why is it important to undertake a local area and market assessment?
- c) Describe the main steps involved in conducting a market and support service assessment
- d) You as a Tillage Service Provider owning a 75 Hp tractor, ripper and trailer practicing CA in Kiteto district serving about 50 farmers with a total area of 100 acres; you want to expand your services to Mkoka village in Kongwa district about 80 km away from your village. Narrate the procedure you will undertake before you engage your services in Mkoka taking into consideration the main issues for making a profitable business
- e) Develop some questions/check list to be used when conducting a Support Service Assessment including Financial Service Providers
- f) What is the information needed in conducting a market assessment?
- g) Why is it important to plan an assessment?
- h) List the main types of services required in a hire service business
- i) List 5 steps required in undertaking a market assessment
- j) Why is a market assessment important for the successful running of a hire service?
- k) What information is necessary to be collected when conducting an assessment of financial sources for a hire service business?
- l) What do you consider in devising a plan for market information collection?

4.3.4. References

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MODULE 4: SELECTING APPROPRIATE MACHINERY - TECHNICAL AND FINANCIAL ASPECTS

4.4.1. Introduction

Machinery is a major component in crop production costs and is an indispensable part of the agricultural production system. Thus the selected machine needs to be the most cost effective; that is, one which performs the required task in a satisfactory way at the lowest feasible cost accomplishing the job on time. In Conservation Agriculture based systems; the selected machine should lead to minimum soil disturbance and should be able to work in trashy field conditions.

Learning objectives



At the end of the module the learner /trainee should be able to:

- Recognize the importance of planning in the selection of power sources, machines and associated implements.
- Understand the numerous factors influencing the selection of power sources and implements.
- Understand the technical and financial criteria involved in the selection of power sources and equipment.
- Identify the logical steps required in the selection process.
- Demonstrate how to carry out the step-by-step selection process.
- To equip hire service providers to make optimal selections of appropriate power sources and implements based on power requirements and implement performance in the field.
- To understand the machinery costs involved in tractor hire business i.e. fixed and variable costs and how to determine the costs per acre that customers can be charged
- Explain how to make investment decisions including cash flows and simple loan appraisals.

Materials	
	Some of the equipment and materials needed for training include laptops, overhead projectors; power point projectors, handouts, posters, fact sheets, training manual, flip charts, writing pads, note books, pens, pencils, masking tape and marker pens.
Training Methodology	
	<ul style="list-style-type: none"> * Facilitation (plenary presentation by facilitator, group discussion, plenary presentation and discussion of group work) * Demonstrations, charts, visual aids /posters * Learning Exercises to enable the participants to share new ideas and experiences and to review and revise the various topics presented. Various case studies may also be introduced to broaden the scope of learning. * Practical or field trips to enable the participants to learn practically the operation, adjustments, maintenance and management of different machines and implements.
Duration:	
	3 hours

Module 4 deals with the technical and financial aspects of machinery selection. The module introduces the steps required for selecting power sources that is tractors and implements for specific tasks. The module imparts the skills required to understand the importance of selecting power sources and implements. Through an analysis of farming systems and other factors (e.g. costs, customers and priorities), it equips participants to make optimal selections of appropriate power sources and implements.



Key concepts and discussions points

Planning the Selection of Power Sources and Implements

The optimal selection of power sources and related implements or equipment is influenced by a wide range of factors, such as soil type, topography, crop type, technical and financial considerations. It is, therefore, essential to carefully plan for the purchase, use and management of power sources and implements, considering the high costs they represent for a hire service business.

Choosing the most appropriate power source and related implements can make the difference between a successful business and a failed venture. Hire service businesses derive their profit from the efficient use of tractors, machines, and implements; for this reason, it is fundamental that any investment in power sources and implements results in improved performance and increased profit. Without improvement and profit, no investment should be made.

It is imperative to analyse the potential outcomes of buying agricultural machinery prior to any investment. A detailed assessment must cover a wide range of factors, in particular:

- Local farms context (e.g. soil types, crop/livestock systems, intensive or extensive farming, high value crops, farm size, topography, local natural environment, climatic conditions and skilled labour availability).
- Market potential (e.g. priorities of farmers and other agrifood value chain actors, prices that can be charged for services, competition by other hire services in the locality).
- Support services (e.g. farm machinery dealerships, spare parts dealers, repair shops, fuel suppliers).
- Technical and financial aspects – with regard to both purchase and use (e.g. field performance of tractors, associated machinery and equipment, purchase prices and running costs, cash availability or cash flow in the hire service business to make such a purchase and the possibility of taking a loan or loan appraisal).

Such an assessment is useful in the decision-making process, although it is not sufficient to eliminate the risk of investing in machinery that does not perform to expectations.

The planning process for power source and implement selection comprises of the following steps:

Step 1: Assessment of local agricultural context (crops, farm sizes, practices, markets and support services)

Step 2: Technical assessment of power sources and implements

Step 3: Financial assessment of power sources and implements

Step 4: Purchase of Machinery

Assessment of Local Agricultural Context

The first process in the selection of agricultural machinery is to undertake a Local Area and Market Assessment (See Module3). A detailed assessment of farms, markets, competition and support services, provides a foundation on which to plan for the selection of appropriate mechanization equipment.



Power tiller – multipurpose smallholder



4WD tractor – increased traction



Big tractor 160 Hp-high field capacity

Figure 1: Selection of power sources according to type of work and farm size

Technical Criteria for the Selection of a Tractor and Implements

The main investment for a hire service business is often tractors, to which a great variety of implements can be attached; hence it is imperative to understand the criteria for assessing a tractor. Tractors are extremely versatile and provide the power for a wide range of applications; they pull implements and deliver engine power through the power take-off (PTO) shaft. Tractors are available in many different sizes and configurations (including both two- and four-wheel categories). Four-wheel tractors (4WTs) may be either two-wheel drive (rear wheels only are driven) or four-wheel drive (front and rear wheels are driven) for greater traction.

To avoid wasted expense, establish how many tractors of what size the hire service needs. A too small tractor can result in long hours in the field, excessive delays and premature replacement; on the other hand, a too large tractor may entail excessive operating and overhead costs. An ideal piece of equipment completes the job (performs the service) on time at the lowest possible cost.

Requirement and Size of the Machine

The technical aspects that influence the selection of the size and number of machines in a hire service business include the power requirement of the intended field operations, machine performance and field characteristics.

Power Requirement

Soil type especially the texture, structure, moisture content and compaction determine the draught requirement hence the tractor power needed or size (Hp/kW). Tractor sizes range from 5 Hp for single axle tractors commonly known as power tillers to more than 600 Hp for double axle tractors. Tractors within a range of 40-100 Hp can accommodate most of the agricultural operations/activities in small and medium scale farming.

The power or tractor size is usually calculated based on the soil draught requirement as in most cases the maximum tractor power is largely dictated by the draught demand for primary tillage. Depth of cut, width of cut, tool shape (including cutting edges), tool arrangement and travel speed are factors that affect draught for a specific soil condition.

Some general guidelines are usually provided by manufacturers on the draught requirements in various types of soils which may serve as a guide to your calculations. The draught requirements may be provided per meter width of the equipment or per shank for tined implements like rippers, subsoilers and chisel ploughs.

Table 1: Draught Power Requirement for Different Implements

Operation/Implement	Draught Power Requirement
Mouldboard or Disc Plough	25 kW/m or 33 Hp/m width of cut
Chisel Plough or Ripper	10 kW/m or 13 Hp/m width of cut
Disc Harrow	6 kW/m or 10 Hp/m width of cut
Planter	2.6 kW or 3.5 Hp/planting line

However, it should be noted that the calculated draught power for pulling the implement in the soil, is just part of the tractor power required; as not all power that is generated by the tractor engine is transmitted to the drawbar or PTO for work or field operations. Part of the generated tractor power is used for running such ancillaries as the gearbox, alternator, differential and water pump. This is usually termed as friction power loss; that is power required to run the tractor without production of any useful work.

The Drawbar power varies depending on several factors such as weight on the tyres, soil type, surface (compacted or loose), condition of the tyre, soil moisture content, soil type (frictional or cohesive), speed, and wheel slippage.

It is common to express the tractor power in PTO HP, which is usually about 85% of the engine power generated. The drawbar power delivered by a tractor is usually not more than two thirds of its pto power mainly due to slip at the tyre/soil interface as well as increased rolling resistance. The recorded drawbar power may be 50-60% of the engine power generated.

Generally, a wheeled tractor when operating on soil can pull about two-thirds of its weight. Most tractors can increase the weight on the drive wheels by filling the tyres with water, adding wheel and front-end weights and using the weight transfer gained by using three-point linkage mounted implements. Four Wheel Drive (4WD) tractors are considered when working in heavy sticky soils where the tractive draught is high because of their additional traction at the front wheels.

Machinery Performance

The machine output considerably affects the time at which field operations can be accomplished and hence the selection process of equipment. The rate at which an operation is accomplished by a machine is mostly expressed as the field capacity or the throughput.

- i. **Field Capacity:** the maximum potential area that can be worked in a given amount of time. It is the possible maximum area worked at a given operating speed, fully utilizing the operational width of the machine given in acres/hr or ha/hr. On the basis of field capacity, it is possible to calculate the number of tractors, implements and machines needed, the number of operators required and the area to be covered. The Field Capacity may be derived from the following Formula:

$$\text{Field Capacity} = \frac{\text{Operating Speed (km/h)} \times \text{Width of the Implement (m)}}{10} = \text{ha/h}$$

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However, when tractors work in the field; in most cases the implements are not used to their full width because of overlapping and also there are some routine interruptions for turning and implement adjustments. Hence the actual (Effective) worked area is usually smaller than the potential maximum area.

- ii. **Field efficiency:** is the ratio of the actual rate of work to the theoretical spot or maximum rate of work. This is an indication of the effectiveness of carrying out field work. Its value is determined by the actual time the tractor is productively working. Field efficiency is achieved by ensuring that the unproductive time in machine operation is kept to a minimum. Wide machines, long fields, fast speeds, quick turns and rapid materials handling procedures contribute to a high overall rate of work. Small, irregularly shaped fields on the other hand lead to low machine field efficiency because the machine spends a lot of time turning, thus not working productively.

Therefore, the actual work rate of an implement depends on three variables; that is the effective working width of an implement excluding the overlapping; operating speed under normal work conditions and the Field Efficiency.

Field Characteristics

Field characteristics that influence machine selection include:

- Field size and shape
 - Big fields need bigger tractors and wide implements for higher efficiency
 - Small or irregularly shaped fields need small machines as big machines are unsuitable due to difficulties in manoeuvrability and high unproductive time.
- Topography

Operations are often restricted in fields with steep slopes to avoid overturning of tractors. Such fields are also unsuitable environmentally because of soil erosion.
- Cropping patterns such as a single crop per year, double, multiple or mixed, determine the types of machinery required; sometimes a variety of machines may be needed.

Generally, the larger the field, the greater is the field efficiency. Some studies have established that the same tractor and implement spends 71% of its time on effective work when working on a 100-acre farm compared to only 37% of its time when working on a 5-acre field. In the later, 24% of the tractor's time is spent on turning in the field while in the former it is only 10%.

Financial Aspects in the Selection of a Tractor and Implements

Financial analysis of the intended machinery hire business has to be carried out before an investment is made as the purchase price, operating costs and cash availability or cash flow have an influence on the machinery selection. The price of any machine should always be considered in relation to the services it can provide and the revenues it can generate. It is important to determine if the initial investment costs of purchasing equipment (*tractor, ripper, planter, sheller, trailer or boom sprayer*) can be recovered during the effective or productive lifetime of the particular equipment in the hire service.

Thus it is essential to prepare a proper Business Plan that will guide the machinery service provider in making appropriate investment decisions. When loans are applicable, a loan appraisal should be carried out to ascertain whether the payback period can be covered by the hire service.

Business Plan

A Business Plan is a formal written document composed of business goals, the methods and the time frame for achieving those goals. It provides a description of the nature of the business, background information of the organization, the business entity financial projections, and the strategies for achieving the targets. Generally, this document serves as a road map of the business (hire service).

A business plan guides you on the annual machinery costs and expected revenues. It establishes the Break-even point that is the point where total costs equal total revenues. Break-even calculations show the sales volume required to cover fixed and variable costs and reveals whether the business is viable. A business plan makes you to understand your business better; it helps in managing the business more effectively by making more informed decisions.

Machinery Costs

The correct and appropriate selection of a power source and equipment determine costs and significantly affects the profitability of a hire service. It is crucial, during the selection process, to estimate the purchase and operation costs involved to obtain an indication of how much money the hire service needs to keep operations going on.

There are two main types of costs that are involved in machinery operation, that is fixed and variable costs.

Fixed costs or ownership costs include depreciation of the machine, interest on the capital used, insurance, shelter, taxes and other overhead costs. Fixed costs are incurred whether a machine is used or not. Such costs increase in proportion to the size of the machinery and the greater the utilization of a machine, the lower is the unit cost of operation (hour or per unit of area). Fixed costs are rarely considered by the majority of tractor owners in their annual machinery costs as generally they do not involve direct cash transactions.

Depreciation: it is the loss of equipment value over time. This is a cost resulting from wear, tear, obsolescence and age of machinery. It is the gradual and permanent decrease in the value of a machine and depends on the economic life of the machine and the salvage value at the end of its economic life.

$$\text{Annual Depreciation (Tshs)} = \frac{\text{Purchase Price} - \text{Salvage Value}}{\text{Useful Life Time (years)}}$$

Interest: It is the cost of using money. The cost of borrowed money would be the rate charged by the lender. In case the tractor is bought with equity capital, interest costs still need to be included as the money could earn income in other usages.

$$\text{Annual Interest} = \frac{[\text{Purchase Price} + \text{Salvage Value}]}{2} \times \text{Interest Rate \%}$$

2

Other fixed costs include insurance, housing costs (shed), road licensing costs etc. Insurance costs are variable but a machine's insurance cost is usually estimated at 1% of the Purchase price and shelter at 0.5% of the purchasing price.

Variable costs are associated with machinery utilization and they increase proportionally with the amount of operational use of a given machine. These include fuel and lubricants; repair and maintenance and labour. The estimation of variable costs is usually based on hours of use of the equipment.

Various studies in the country indicate that the average diesel consumption ranges between 4-6 lts/ acre in ploughing and 2-3 lts/acre in ripping (minimum tillage). Lubrication costs are usually estimated at 10-15% of the fuel costs. Repair costs vary considerably and the accumulated tractors repair costs over the lifespan of the machine can amount to 30-50% of the capital cost. Repair costs may be reduced by proper machinery operation and management which includes carrying out recommended machine maintenance schedules and utilizing skilled properly trained operators. In most cases, fuel is the single most costly item contributing up to 60% of the variable costs in the hire service business.

Cash Flow Analysis

Cash flow is a statement which shows the amount of funds flowing into the business (*cash inflow*) and the total amount of money getting out of the business (*cash outflow*) at a particular time period of business operation. The purpose of a cash flow statement is to provide information about the hire service enterprise Gross Receipts and Gross Payment for a specified period of time (month, quarter, semi-annual, annual, etc.). If it happens that the cash inflow is lower than the expenditure (cash outflow), the hire service provider should critically assess the hire service activities that result to high cash outflow (expenses) and find out how to reduce those expenses.

A Cash flow analysis measures how much cash is generated and spent by a CA hire service enterprise during a given period of time. When a loan is taken; a Cash flow analysis helps to predict if the hire service can generate enough funds to repay the loan as specified in the agreement and meet other operating expenses of the business. It enables a hire service to ascertain the money flowing in (revenue) and the money flowing out (expenses) over the loan repayment period.

The cash flow analysis follows five steps:

- i. Record the money coming in and out of the hire service each day. For example, in the example below in September and October there were expenses for fuel, lubricants, repair and maintenance and labour, while payments were made for ripping or minimum tillage.
- ii. Tabulate the money coming in (revenue) and the money going out (expenses) over time (e.g. months and years), creating a cash flow calendar.
- iii. Calculate the cash coming into the hire service (cash inflow) and cash leaving the hire service (cash outflows).
- iv. Calculate the net cash flow, which records month by month the cash position of the hire service.
- v. Ascertain the cumulative net cash flow, defining the availability of money in the hire service, in this case per month.

Once the cash flow calendar is complete, it provides an indication of whether loan repayments can be made during the payback period and predicts the effects on the cash flow of the hire service.

Appraisal of Capital Investments for Hire Services

Before starting a hire service enterprise, it is important for the prospective hire service provider to undertake an in-depth analysis of the investment to determine if the initial investment costs of purchasing equipment (*tractor, ripper, planter, sheller, trailer or boom sprayer*) can be recovered during the productive life time of the particular equipment. For a profitable investment; the long-term benefit of an investment must be greater than the initial cost: the “return on capital”.

Two methods, both based on cash flow may be used to assess the profitability of an investment; that is the Payback Period and Rate of Return to Investment.

Payback Period. This method calculates the number of years required for an investment in machinery to return its original cost by generating income. It assesses the time needed for the cumulative income from the investment to equal its initial cost. It is useful for selecting the most appropriate area for investment. An investment with a shorter payback period is more attractive than one with a long payback period as it only requires short-term financing.

The payback period can be determined by assessing the Annual Cash Flow expected after making an investment, which is the difference between the Cash Inflows and Cash Outflows for every year during the planned investment period; which is then divided by the initial investment cost.

To calculate the payback period, follow the following Steps:

- i. Determine the Investment Cost (IC) of the Equipment and the expected Investment Period (Y)
- ii. Calculate the Annual Cash Flow (ACF):

$$\text{Annual Cash Flow} = \text{Cash Inflow} - \text{Cash Flow}$$

- iii. Determine the Average Annual Cash Flow (X) over the Investment period:

$$\text{Average Annual Cash Flow} = \frac{\text{Total Annual Cash Flow}}{\text{Investment Period (years)}}$$

- iv. Calculate the Payback Period:

$$\text{Payback Period} = \frac{\text{Investment Cost}}{\text{Average Annual Cash Flow}} = \frac{IC}{X}$$

Rate of Return to Investment. This expresses the average annual net income as a percentage of the investment. This method recognizes that not only income is important to the business, but also the amount of money used to produce it. Income is regarded as a return on the money invested. The return on money invested is compared to the cost of money invested and is used to compare alternative investments. The higher the Rate of Return (RR) the most suitable the business is.

To calculate the Rate of Return (RR) follow the following steps:

- i. Determine the Investment Cost (IC) and Annual Depreciation (D) of the Equipment and the expected Investment Period (Y)

- ii. Calculate the Annual Cash Flow (AC):

$$\text{Annual Cash Flow} = \text{Cash Inflow} - \text{Cash Flow}$$

- iii. Determine the Average Annual Cash Flow (X):

$$\text{Average Annual Cash Flow} = \frac{\text{Total Annual Cash Flow}}{\text{Investment Period (years)}}$$

- iv. Determine the Average Annual Net Income: (ANI)

$$\text{Annual Net Income} = \text{Average Annual Cash Flow} - \text{Annual Depreciation (X-D)}$$

- v. Calculate the Rate of Return (RR):

$$\text{Rate of Return (RR)} = \frac{\text{Average Annual Net Income}}{\text{Investment Cost}} = \frac{ANI}{IC}$$

Loan Appraisal

Loan appraisal is an evaluation done to determine if the borrower will be able to afford to repay the loan over the given agreeable period. In other words, it is a process of determining the viability of the loan.

The following factors should be taken into consideration in determining the viability of a loan:

- *Benefits to be gained;*
- *Costs to be incurred;*
- *Terms and Conditions of accessing the service;*
- *Reliability of the lender;*
- *Interest Rate (IR); and*
- *Payback Period (PBP)*

To make a loan appraisal, draw up a cash flow calendar to show what is expected in the future; from when the loan is received until it is repaid. The loan appraisal for a tractor typically covers a period of 3-5 years and for implements 1-2 years. The cash flow calendar should include detailed information about various types of payback period and highlight when repayments are due. Consideration should also be made on collateral (assets) required to provide a guarantee on the loan; the risks and responsibilities entailed and the fact that tractor investments usually require longer-term loans with lower interest rates because of the vulnerability to weather conditions. In most cases the ideal

mean for purchasing new equipment for a small-scale hire service business are own savings or from financial institutions with moderate terms.

Purchase Process

The purchase process is the final step in the planning process for selecting power sources and implements and is based on all the previous steps of the planning process and related information. It involves a field trip to local dealerships making a critical assessment, with a focus on the purchasing aspects. Availability of support services or after-sale services such as spare parts and technical support is one of the critical factors for selection. When spare parts are readily available, downtimes are kept very short, making the machine more productive during the season. When a machine breaks down, it stops making money; the more it stays idle because of lack of spare parts the more the hire service loses revenue. Sometimes such breakdowns occur at peak demand when the machine is highly in need. This may be critical not only to the service provider but also to his customers because of the vulnerability of agriculture to seasonality and timing. It may also affect the business negatively as customers lose trust because of the unreliability nature of the hire service due to lack of spare parts.

Other factors which have to be taken into consideration include price and quality of the machine; financial incentives such as credits/higher purchase arrangements and special warranties; and collateral arrangements for the purchased machine. Therefore, it is important shopping around, visiting several dealers and assessing the situation before the last decision is made to purchase a specific type of a machine. Make a detailed check list prior to your visit to guide you in data collection and decision making. Information gathered during the local area and market assessment (Module 2) will be useful; complimented with information from other service providers who are already engaged in the hire service business.

Profitability of Machinery Hire Services

The main factors that influence the profitability of a machinery hire service include the size of the capital invested, type of selected machinery, the business volume that generate incomes (cash inflow), the price that is charged to the customers for the services rendered and the expenditure or operational costs (cash outflow). Machines should work enough hectares in a season to cover the costs of operation as well as generating an income surplus to cover loan serving and other obligations. Data from Kongwa and Kiteto districts, indicated that tractor owners gained more profits in the tractor hire business as they ploughed more acres. Those who ploughed 200 acres per season gained less than one million shillings in profit; those who ploughed 400 acres obtained about Tshs 2,000,000.00 rising to Tshs 4,000,000.00 for those who ploughed 800 acres in one season.

Machine Operation

Some factors to be considered in machine operation include:

- Availability of support services such as fuel supplies, spare parts, mechanics etc. close to the area of operation to reduce transaction costs
- Skilful and knowledgeable operators should be employed to operate and manage agricultural machinery. They should be conversant with operation, machinery adjustments and routine maintenance of the machines.
- Repair and Maintenance schedules. Each machine should have a maintenance schedule so that the operator and workshop have a checklist of work that has to be carried out. Maintenance occurs at three levels; operator level, scheduled maintenance level and major service level.

- Record keeping. A daily logbook of all work carried out should be kept by the operator for each tractor/machinery. This gives a means whereby the business can keep track of costs and returns for each of its machines.
- Planning work schedules and proper communication with customers before engagement reduce unproductive time thus increasing efficiency of field operations
- Financial management. Income and expenditure to be tracked regularly to identify areas of improvement including review of costs.

How to Reduce Machinery Costs?

The most critical success factor in reducing machinery costs is to increase the utilization rate of the machine. Down times need to be kept at a minimum by for example following a regular maintenance schedule. A comprehensive set of records of all machinery should be kept so that continuous monitoring of costs can be carried out.

Machine utilization, productivity and efficiency of operation can be improved by the following measures:

- *Increasing efficiency* by organizing work such that travel distance between individual farmer fields is minimized; organizing daily work programmes so that as many fields as possible in the same area can be covered at one time;
- *Working with as many farmers as possible* in the same area by encouraging synchronization of individual field operations to coincide;
- *Increasing machine utilization in peak periods* by working longer periods; training and improving operator skills to work more efficiently;
- *Working with farmers with larger field sizes* or by encourage farmers to increase field sizes through land consolidation;
- *Working with farmers engaged in contract farming agreements with crop buyers* as such farmers are usually found in the same area practicing similar cropping patterns to meet specific requirements of the crop buyer;
- *Looking for additional work in periods of low activity* or in other localities with different seasonal operations;
- *Improving operator skills* including driving, minimizing breakages, servicing and basic maintenance. The possibility of
- *Introducing incentives* for careful and skilful operators who have fewer breakdowns and high work rates.

Lifecycle Cost benefit analysis

It is also very important to carry out a general lifecycle cost analysis or Total Cost of ownership analysis before making a decision to own a machine or hire a machine. Lifecycle analysis will help you determine the most cost-effective option among different competing alternatives to purchase, own, hire and finally dispose of a machine or service. It is used to compare various options by identifying and assessing economic impacts over the life of each option.

All costs incurred in the life of owning or hiring a machine must be considered before purchase or hire of the machine or equipment. Life Cycle Costs are those costs incurred on a machine during its life cycle, or a part of its lifecycle (when you are using it) to meet its performance requirements.

A combination of IRR, NPV and lifecycle analysis will give a service provide a basis to hire, own or purchase specific equipment.

4.4.3. Review questions

Encourage participants to share their experiences and ask the following questions:

- a) Why is it important to carefully plan for the selection of power sources and implements?
- b) Which factors need to be taken into account when considering the selection of power sources and implements?
- c) Why is a step-by-step approach important in the selection of power sources and implements?
- d) How do you normally estimate the size of the implement you use?
- e) What is the “field capacity” of a machine?
- f) What is “field efficiency” and what factors determine it?
- g) What is “actual work rate”?
- h) What does the term “draught requirement” mean? How does drawbar power relate to engine power?
- i) Explain why is it important to prepare a Business Plan before you engage yourself in machinery hire service business
- j) Explain the importance of costing field operations in a hire service business
- k) Which type of tractor is most popular in your area and why? What criteria did you take in selecting the type and size of tractor you own?
- l) Why is it important to undertake a financial analysis as part of the machinery selection process?
- m) What do you understand by the term Payback Period and Rate of Return to Investment?
- n) Explain the main factors that should be taken into consideration when conducting an assessment of the local agriculture context in relation to the selection of power sources and implements.
- o) Discuss the main factors that influence the profitability of a machinery hire service business
- p) What are the main factors that have to be considered in machine operation and management?
- q) Discuss how you can go about in reducing the machinery operation costs in a hire service business

4.4.4. Learning exercises

Learning Exercise 4.1: Machinery Selection – tractor and seeder

Divide the participants in small groups of 4-6 people and give them enough time to work on the following questions. While working encourage them to share their own practical experiences; after that the groups should present their work in plenary sessions to allow more broad based discussions and further sharing of experiences and knowledge with facilitators.

Question 1: A Hire Service Provider in Engusero village Kiteto district intends to buy a direct seeder for planting maize at a spacing of 75 cm. He has a selection of a 4 row direct seeder or a 3 row direct seeder both with hoppers spaced at 75 cm. His operator works a maximum of 8 hours/day. The operating speed of the direct seeder is 6 km/hr working at a Field Efficiency of 65% and the draught requirement is 3.5 Hp/line.

- What seeder will he/she select in order to enable him/her to work at least 8 hectares per day?
- What would be the minimum tractor engine horsepower recommended for the selected direct seeder?

Solution:

a) Seeder Selection

Seeder 1: 4 Rows

Width of the planter = 0.75 m spacing x 4 rows = 3 m

Field Capacity = $\frac{\text{Speed (6 km/h)} \times \text{width (3 m)}}{10}$ = 1.8 ha/hour = 4.5 acres/hr

AWR = $\frac{\text{Speed (6 km/h)} \times \text{width (3 m)} \times \text{efficiency (65\%)}}{10}$ = 1.2 ha/hour = 3 acres/hr

Actual Work done per day = 3 acres/hr x 8 hrs = 24 acres/day

NB: AWR – Actual Work Rate

Seeder 2: 3 Rows

Width of the planter = 0.75 m spacing x 3 rows = 2.25 m

Field Capacity = $\frac{\text{Speed (6 km/h)} \times \text{width (2.25 m)}}{10}$ = 1.4 ha/hour = 3.5 acres/hr

AW Rate = $\frac{\text{Speed (6 km/h)} \times \text{width (2.25 m)} \times \text{efficiency (65\%)}}{10}$ = 0.9 ha/hour = 2 acres/hr

Actual Work done per day = 2 acres/hr x 8 hrs = 16 acres/day

The Hire Service Provider will select the 4 row direct seeder as he will be able to plant 24 acres/day compared to the 3 row direct seeder which is able to plant 16 acres/day which is below the gauged work rate of 20 acres/day.

b) Size of Tractor required for the planting operation:

Draught requirement for 4 row seeder at the drawbar = 3.5 Hp/line x 4 = 14 Hp

The Engine Hp will be: $\frac{14 \times 100}{60} = 23$ Hp (Drawbar power = 60% Engine power)

60

Therefore, a 23 Hp tractor will be needed to pull the 4 row direct seeder in the planting operation.

Learning Exercise 4.2: Determining service charges & revenues

Question 2: After making a local area and market survey/assessment in Kongwa district, a hire service provider establishes that he can provide reduced tillage (ripping) services to about 250 farmers annually with a total of 800 acres in Mkoka division between September and November. He owns a 60 Hp tractor and a 1 meter wide three gang ripper. The following additional information is provided in the farm records:

Table 8: Farm Records of a Service Provider in Kongwa District

Item	Tractor	Ripper	Tractor & Ripper	
Purchase Price (PP) Tshs	37,500,000	6,000,000	Fuel Consumption (lts/acre)	2.5
Size	60 HP	1 metre wide	Lubricants 15% Fuel cost	15%
Salvage value (Tshs)	5,000,000	1,000,000	Repair & Maintenance	30%PP/yr
Life Span (years)	10	10	Work done (ripping) acres/yr	800
Interest % per annum	8	8	Speed (km/hr)	7
Shelter	(0.5%PP/year)	(0.5%PP/year)	Field Efficiency	85%
Insurance Tshs/yr	(0.3%PP/year)	(0.5%PP/year)	Labour cost-operator Tshs/acre	5,000
Fuel cost is Tshs 2,200/litre				

- Find out if the 60 Hp tractor will be able to work in Mkoka division given the draught requirement of the soils in the division is 10 Hp/tine
- Calculate the Annual Fixed and Variable costs and establish the total machinery cost/acre
- Find the rate at which the service provider may charge his customers per acre at a profit margin of 20% and if he will be competitive if most of the service providers charge their customers Tshs 30,000/acre?
- What will be the revenue that he will collect and the Gross Margin obtained when he charges at the derived rate (at 20%) and when he charges Tshs 30,000/acre as other service providers?
- If the operator works for 8 hr/day from 8 am to 5 pm with a one-hour lunch/healthy break:
 - How many acres will the operator be able to till per day if the Field Efficiency is 85%?
 - How many acres will the operator till in the season given that the available days in September is 25 days, October 26 days and November 24 days.

Solution:

a) **Tractor Size**

Work out the soil draught requirement for the ripper first

The Drawbar power requirement = $10 \times 1 \times 3 = 30 \text{ Hp}$

The Engine Hp will be: $\frac{30 \times 100}{60} = 50 \text{ Hp}$ (Drawbar power = 60% Engine power)

A tractor of 50 Hp will be needed for ripping in soils in Mkoka division; therefore, the 60 Hp tractor owned by the service provide will suffice.

b) **Annual Fixed and Variable Costs**

Annual Fixed Costs: Tractor

- i. Depreciation per annum = $\frac{37,500,000 - 5,000,000}{10} = 3,250,000$
- ii. Interest per annum = $\frac{37,500,000 + 5,000,000}{2} \times 0.08 = 1,700,000$
- iii. Shelter per annum = $\frac{37,500,000 \times 0.5}{100} = 187,000$
- iv. Insurance per annum = $37,500,000 \times 0.3/100 = 112,000$

Tractor Annual Fixed Costs: i + ii + iii + iv = 5,250,000

Annual Fixed Costs: Ripper

- v. Depreciation per annum = $\frac{6,000,000 - 1,000,000}{10} = 500,000$
- vi. Interest per annum = $\frac{6,000,000 + 1,000,000}{2} \times 0.10 = 280,000$
- vii. Shelter per annum = $\frac{6,000,000 \times 0.5}{100} = 30,000$

Ripper Annual Fixed Costs: v + vi + vii = 810,000

Total Annual Fixed Cost Tractor + ripper = 5,250,000 + 810,000 = 6,060,000

Variable Costs Tshs/year

- i. Fuel cost = $2.5\text{ lts/acre} \times 800 \text{ acres} \times 2,200 = 4,440,000$
- ii. Lubricants = Fuel cost $\times 15\% = 4,440,000.00 \times 0.15 = 660,000$
- iii. Tractor Repair & Maintenance Costs/year = $30\%PP/10 \text{ years} = 37,500,000 \times .3/10 = 1,125,000$
- iv. Ripper Repair & Maintenance Costs/year = $30\%PP/10 \text{ years} = 6,000,000 \times .3/10 = 180,000$
- v. Labour – Operator Cost/year = $800 \text{ acres} \times 5,000 = 4,000,000$

Total Annual Variable Costs = i + ii + iii + iv + v = 10,365,000

The Total Annual Machinery Costs = Fixed + Variable Costs = 16,425,000

The service provider will till 800 acres in the season; then the Machinery Costs/acre will be: **Tshs 16,425,000/800 = 20,531/acre**

c) Charges to Customers for Ripping Services (Rate/acre)

The machinery cost for ripping = Tshs. 20,531/acre

The Rate to charge customers at a Profit margin of 20%
 $= 20,531 + (20\% \times 20,531) = 20,531 + 4,106 = 24,637$.

Therefore, the service provider will charge his customers
Tshs. 25,000/acre to make a profit of 20%

d) Revenue and Gross Marginsx

Work the two scenarios as in the table below:

Table 9: Gross Margins at Tshs 25,000/acre and Tshs 30,000/acre

Area Cultivated (Acres)	Expenditure: Ripping Machinery Cost Tshs		Revenue Tshs		Gross Margin Tshs
	Rate/acre	Amount	Rate/acre	Amount	
800	20,531	16,424,800	25,000	20,000,000	3,575,200
800	20,531	16,424,800	30,000	24,000,000	7,575,200

Gross Margin (GM) = Revenue – Expenditure

GM 1 = (800 acres x 25,000/acre) – (800 acres x 20,531/acre)
 $= 20,000,000 - 16,424,800 = 3,575,200$

GM 2 = (800 acres x 30,000/acre) – (800 acres x 20,531/acre)
 $= 24,000,000 - 16,424,800 = 7,575,200$

The service provider will generate an income of Tshs 20,000,000 when he charges farmers at Tshs 25,000/acre and a Gross margin of Tshs 3,575,000 while he will generate an income of Tshs 24,000,000 and a Gross margin of Tshs 7,575,000 when he charges farmers at Tshs 30,000/acre.

e) Work rate/day and area tilled in a season

Width of the ripper = 1 m

Field Capacity = $\frac{\text{Speed (7 km/h)} \times \text{width (1 m)}}{10} = 0.7 \text{ ha/hour} = 1.75 \text{ acres/hr}$

Actual Work Rate = $\frac{\text{Speed (7 km/h)} \times \text{width (1 m)} \times \text{efficiency (85\%)}}{10} = 0.6 \text{ ha/hour} = 1.5 \text{ acres/hr}$

i. **Actual Work done per day = 1.5 acres/hr x 8 hrs = 12 acres/day**

ii. **Acres tilled/ripped in a season = 12 acres x 75 days = 900 acres**

Discuss in your group what have you learnt from this Exercise, your practical experiences and how useful will it be applicable in your hire service business.



Learning Exercise 4.3: Calculation of Machinery Work rates and Cash Flow

Question3: A Hire Service Provider in Matui village Kiteto district owns a 75 Hp tractor, 3-disc plough, 3 gang ripper, a direct seeder, a 42 blade rotavator and a 7-ton trailer. In a season he ploughs 500 acres, ripping 300 acres, direct seeding/planting 300 acres, puddling 200 acres and provides haulage services making 150 trips. The following is data extracted from his farm records:

Table 10: Farm Records for a Hire Service Provider owning a 75 Hp Tractor

Machinery or Implements Owned	Price Tshs	Life Span (years)	Activity	Fuel Consumed lt/acre	Area Cultivated (Acres/Season)
Tractor 75 Hp	52,000,000	10	Ripping	3	300
Ripper 3 Tine/shank	7,000,000	10	Ploughing	5	500
Plough 3 Discs	5,000,000	10	Direct seeding	3	300
Direct Seeder 4 row	12,000,000	10	Puddling	6	200
Rotavator	8,000,000	10	Haulage/trip	2	150
Trailer 7 tons	7,000,000	10			
Operations	Month	Area (acres)	Operations	Month	Area (acres)
Ripping	September	100	Puddling	February	100
	October	200		March	100
Ploughing	November	150	Haulage (trips)	March	10
	December	250		April	20
	January	100		May	20
D/seeding	November	150		June	30
	December	100		July	40
	January	50		August	30
Customer Charges for various field operations (Tshs)					
Ripping	30,000/acre	D/Seeding	35,000/acre	Haulage	30,000/trip
Ploughing	30,000/acre	Puddling	60,000/acre	Fuel Cost	2,200/litre
Monthly Repair and Maintenance Costs for Tractor & Implements (Tshs)					
January	270,000	May	52,000	September	190,000
February	240,000	June	78,000	October	380,000
March	266,000	July	104,000	November	585,000
April	52,000	August	78,000	December	615,000
Implement	Speed km/hr	Width m	Efficiency %	Operation Costs	
Ripper	7	1.2	0.85	Operator cost	5,000/acre
Plough	7	1.0	0.85	Fuel Cost	2,200/litre
Direct Seeding	6	3.0	0.65	Lubricants	10% Fuel
Puddling	4	1.2	0.60		
Item (Tshs)	Tractor	Ripper	Plough	D/Seeder	Rotavator
Purchase Price	52,000,000	7,000,000	5,000,000	12,000,000	8,000,000

- Find the Actual Work Rate [AWR) in acres/hr of the ripping, ploughing, direct seeding and puddling operations.
- Calculate the number of days needed to accomplish the ripping, ploughing, direct seeding and puddling operations in specific months from September when the season starts to March given that the operator works for 8 days per day.
- Calculate the Annual Fixed and Variable costs and establish the total machinery cost/acre for ripping, ploughing, direct seeding and puddling.
- Prepare a Monthly Cash Flow Calendar over the given season for the Hire Provider Service Provider based on the monthly Income and Expenditure.

Solution:

a) **Work Rate**

$$\text{Actual Work Rate} = \frac{\text{Speed (km/h)} \times \text{width (m)} \times \text{efficiency (\%)}}{10}$$

i. Ripping

$$\text{AWR} = \frac{\text{Speed (7 km/h)} \times \text{width (1.2 m)} \times \text{efficiency (85\%)}}{10} = 0.7 \text{ ha/hour} = 1.8 \text{ acres/hr}$$

ii. Ploughing

$$\text{AWR} = \frac{\text{Speed (7 km/h)} \times \text{width (1.0 m)} \times \text{efficiency (85\%)}}{10} = 0.6 \text{ ha/hour} = 1.5 \text{ acres/hr}$$

iii. Direct Seeding

$$\text{Actual Work Rate} = \frac{\text{Speed (6 km/h)} \times \text{width (3.0 m)} \times \text{efficiency (65\%)}}{10} = 1.2 \text{ ha/hour} = 3 \text{ acres/hr}$$

iv. Puddling

$$\text{AWR} = \frac{\text{Speed (4km/h)} \times \text{width (1.2m)} \times \text{efficiency (60\%)}}{10} = 0.3 \text{ ha/hour} = 0.8 \text{ acres/hr}$$

b) **Number of days needed to accomplish the ripping, ploughing, direct seeding and puddling**

Calculations are done for field operation each month and results are presented in the Table below:

Table 11: Number of days needed to accomplish various field activities

Month	Operation	Area Worked	Work rate Acre/hr	Acres 8 hrs per day	Days Needed
September	Ripping	100	1.8	14	7
October	Ripping	200	1.8	14	14
November	Ploughing	150	1.5	12	13
	Direct seeding	150	3.0	24	6
December	Ploughing	250	1.5	12	21
	Direct seeding	100	3.0	24	4
January	Ploughing	100	1.5	12	8
	Direct seeding	50	3.0	24	2
February	Puddling	100	0.8	6	16
March	Puddling	100	0.8	6	16

c) **Annual Fixed and Variable Costs**

The Annual Fixed and Variable costs and the total machinery cost/acre for ripping, ploughing, direct seeding and puddling have been calculated as shown in the Table below:

Table 12: Annual Fixed and Variable Costs and Machinery Costs/acre

Annual Fixed Costs	Tractor	Ripper	Plough	D/Seeder	Rotavator	Trailer
Purchase Price	52,000,000	7,000,000	5,000,000	12,000,000	8,000,000	7,000,000
Salvage Value	7,000,000	1,500,000	1,500,000	3,000,000	2,000,000	3,000,000
Acres worked/year	1,300	300	500	300	200	150
Depreciation/yr	4,500,000	550,000	350,000	900,000	600,000	400,000
Interest/yr	2,950,000	425,000	325,000	750,000	500,000	500,000
Shelter	260,000	35,000	25,000	60,000	40,000	35,000
Insurance (0.3%PP/year)	156,000					
Total	7,866,000	1,010,000	700,000	1,710,000	1,140,000	935,000
Fixed Costs/acre	6,051	3,367	1,400	5,700	5,700	6,233
Annual Variable Costs						
Acres worked/year	1,300	300	500	300	200	150
Work Rate acres/hr		1.8	1.5	3.0	0.8	1.0
Hours worked/year	1000	167	333	100	250	150
Repair & Maintenance	1,560,000	210,000	150,000	360,000	240,000	210,000
Fuel Costs/year		1,980,000	5,500,000	1,980,000	2,640,000	660,000
Lubricants		198,000	550,000	198,000	264,000	66,000
Operator - labour		1,500,000	2,500,000	1,500,000	1,000,000	750,000
Total	1,560,000	3,888,000	8,700,000	4,038,000	4,144,000	1,686,000
Variable Cost/acre	1,200	12,960	17,400	13,460	20,720	11,240
Variable Cost/hr	1,560	23,328	26,100	40,380	16,576	11,240
	Tractor	Ripper	Plough	D/ Seeder	Rotavator	Trailer
Total Cost/acre (FC + VC)	7,251	16,327	18,800	19,160	26,420	17,473
Field Operation Cost/acre		23,577	26,051	26,411	33,671	24,724
Rate Charged/acre		30,000	30,000	35,000	60,000	30,000
Margin/acre		6,423	3,949	8,589	26,329	5,276
Profit made/season		1,926,769	1,974,615	2,576,769	5,265,846	791,385
Annual Fixed Costs	7,866,000	1,010,000	700,000	1,710,000	1,140,000	935,000
Annual Variable Costs	1,560,000	3,888,000	8,700,000	4,038,000	4,144,000	1,686,000
Field Operation		Ripping	Ploughing	D/Seeding	Puddling	Haulage/trip
Machinery Operating Cost/acre		23,577	26,051	26,411	33,671	24,724

d) **Monthly Cash Flow Calendar**

- i. Calculate the monthly income generated and the expenditure on consumables as per data provided
- ii. Draw the Monthly Cash Flow Calendar from September when the season starts to August when the season ends as shown below.

Solution: Cash Flow Calendar: Refer to Annex I

4.4.5. Sources of additional/further reading/reference materials

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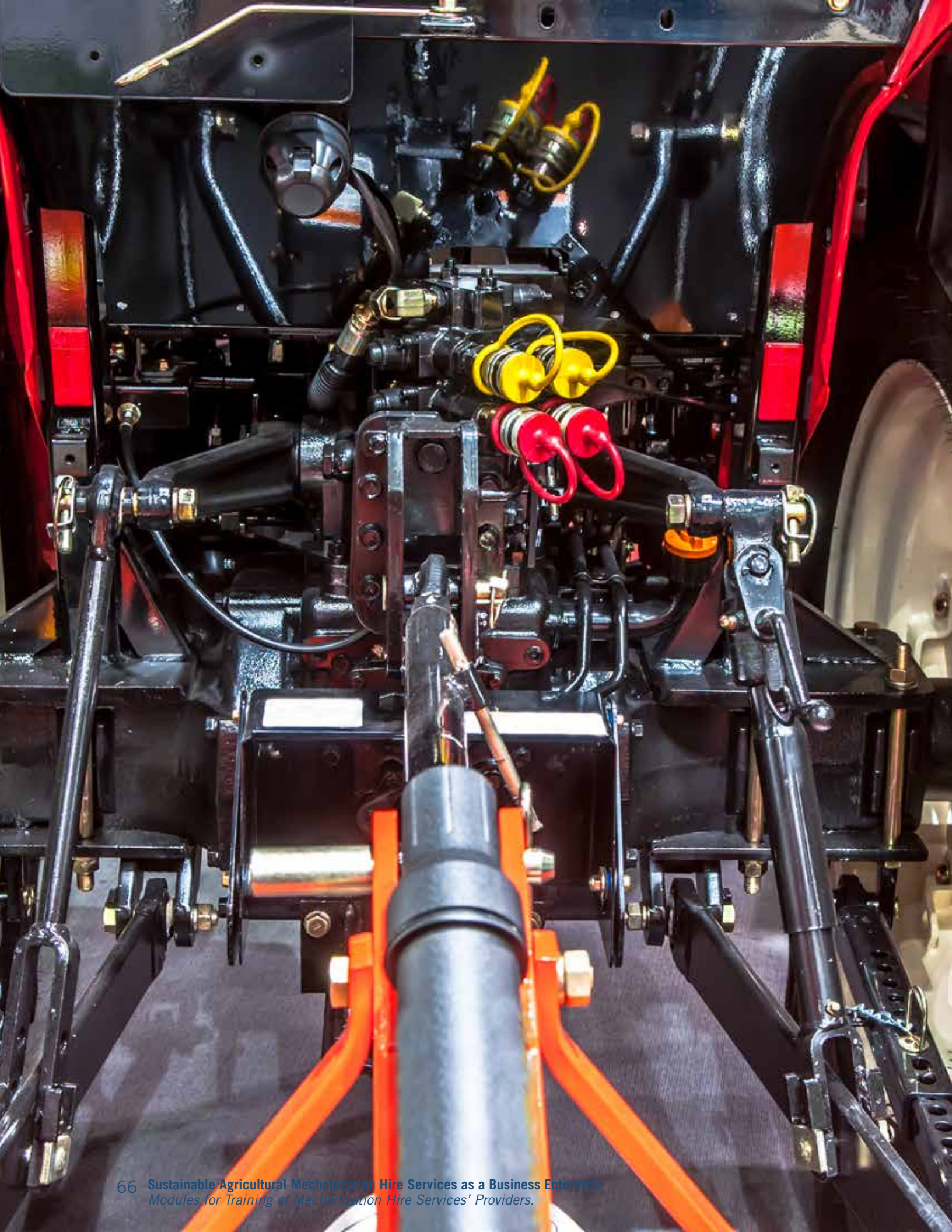
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MODULE 5: OPERATION AND MAINTENANCE OF AGRICULTURAL EQUIPMENT FOR HIRE SERVICE BUSINESSES

4.5.1. Introduction

This module covers the basic technical aspects of tractor, machinery operation and maintenance of agricultural equipment. The focus is on tractors (both two-wheel, 2WT, and four-wheel, 4WT), draught bovines, sprayers, planters, post-harvest equipment and pumps. The equipment discussed includes power sources, implements and machines most likely to be of interest to mechanization service providers for smallholder farmers.

Learning objectives



Learning objectives

At the end of the module the learner /trainee should be able to:

- Understand the basic technical elements of the main power options for agricultural equipment.
- Gain an overview of the different types of equipment available for agricultural operations for hire business services.
- Understand the fundamentals of maintenance of 2WTs and 4WTs and the importance of scheduled maintenance of machinery to keep it operational and to prolong its working life.
- Appreciate the vital importance of safety in the operation of agricultural machinery.
- Understand how to calibrate planters and sprayers.
- Understand the principles of the technical performance of pumps and post-harvest equipment.
- Understand the principles of draught animal care.

Materials



Multimedia projector, or can take place in the workshop around a tractor. The exercise requires access to a tractor and access to the operator's manual. The presence and supervision of trained workshop staff is ideal.

Training Methodology	
	<ul style="list-style-type: none"> * Facilitation (plenary presentation by facilitator, group discussion, plenary presentation and discussion of group work) * Demonstrations, charts, visual aids /posters * Learning Exercises to enable the participants to share new ideas and experiences and to review and revise the various topics presented. Various case studies may also be introduced to broaden the scope of learning. * Practical or field trips to enable the participants to learn practically the operation, adjustments, maintenance and management of different machines and implements.
Duration:	
	3 hours

4.5.2. Key concepts and discussion points

Introduce to the learners the following key concepts and discussion points as you lead the training. Open up for discussion as much as possible and ask as many questions as you can.

The most important note is to carry out regular maintenance on agricultural equipment to ensure a longer machine life. Understanding how to operate, maintain, service and repair equipment results in more efficient output and a longer life of machinery. Machinery maintenance needs to be preventive rather than reactive. Besides, correct maintenance contributes to a more profitable business operation in the long run.

Under this module, the key concepts and discussion points can be categorizing sequentially as follows and selected based on appropriateness to the training:

- i): Concepts on power sources: tractors (4WTs and 2WTs) and draught animals.
- ii): Introduction to the range of equipment available for use with the different power source options, including human muscle power.
- iii): Issues on technical maintenance and safe use: tractor maintenance and safety issues in the use of tractors and sprayers.
- iv): Aspects of simple calibration procedures for planters and sprayers.
- v): Use of tractor power sources beyond crop production: shellers and threshers, and water pumps.

Power options for agricultural equipment

Here, introduce the power options that exist for the various agricultural operations offered by a hire services business. These include: four-wheel tractors, two-wheel tractors and draught animals

I) Four-wheel tractors

The focus here is to introduce the basic technical aspects of four-wheel tractors (4WTs) giving priority to the principal tractor systems, the main points for maintenance and the importance of proper service provision using 4WT

Overview of main systems of four-wheel tractors:

- a). *Tractor instruments:* Review the instruments available (hours, revolutions, fuel gauge, oil pressure, temperature, ammeter, air cleaner) and make sure that you understand what they all indicate:
- b). *Diesel fuel system:* The main components are: fuel tank; fuel lift pump (carries fuel through to the filters); fuel filter (filters fuel into the pump); injection pump (meters and delivers fuel into the cylinders under pressure and at the correct time); and injector nozzles (atomize and spray fuel into the cylinders)
- c). *Air intake and exhaust systems:* The main components are: air intake filter and cleaner (collects dust and dirt from incoming air pulled into the engine); air inlet manifold (transports the air into the engine cylinders); turbocharger (if fitted – normally only on larger engines – forces more air into the engine than could normally be pushed in by atmospheric pressure); and inlet and exhaust valves (control the air entering the system and the exhaust gases leaving the cylinder).
- d). *Engine cooling system:* The main components are (Plate 4.2): radiator and pressure cap; fan and fan belt; the water pump; and thermostat. Some small tractor engines are air-cooled as air is forced by a fan through “fins” on the cylinder block.
- e). *Electrical system:* The main components are: battery; starter motor; and alternator.
- f). *Tractor transmission, hydraulics and clutch:* Most modern farm tractors use the same oil for both the transmission and hydraulic system. In some tractors the brakes are also immersed in special oils (so-called “wet brakes”). Refer to the operator’s manual for full details

2) Two-wheel tractors

Understanding the basic technical aspects, components and maintenance issues of Two-wheel tractors (2WTs) is key to keeping the tractor running as it should and minimizing downtime.

Overview of main systems of two-wheel tractors

Many of the systems of a four-wheel tractor (4WT) also apply to two-wheel tractors (2WTs). The forward-mounted diesel engine of a 2WT drives the transmission via a V-belt and pulley system. The gearbox drives the wheels through dog clutches that are used to steer the tractor at work. If a rotary tiller is incorporated, it is activated by a separate gear lever and the rotary cultivator shaft is driven by a chain and sprocket transmission. Normally, it is not possible to engage the rotary cultivator with the tractor reverse gear selected.

Principal 2WT systems

- a). *Fuel system:* Simpler than in a 4WT, it has the same elements except for the fuel pump. Fuel is fed to the injector pump by gravity, then distributed into the cylinders through the injector.
- b). *Air intake system:* It is common to have oil-bath cleaners on 2WT diesel engines.
- c). *Engine lubrication system:* Essentially similar to that of a 4WT.
- d). *Engine cooling system:* 2WT diesel engines are usually cooled by an evaporative system. Water is boiled in the cooling pan above the engine and must be replenished when the level falls below a predetermined minimum signalled by a float system. Clean, soft water should be used and the system should be drained over winter if there is any danger of sub-zero temperatures and freezing.
- e). *V-belt and transmission:* The V-belt is the key element that transfers the power generated in the engine to the wheels of the tractor via the clutch and gearbox. It is normally made of special rubber-based materials. Each engine/tractor has its specific type of V-belt; material, size and shape of the pulleys are elements that determine the correct type of belt to be used.

- f). *Steering system dog clutches*: The gearbox drives the wheels through dog clutches that are used to steer the tractor in work. Play in the clutch control system is eliminated by adjusting the lengths of the steering pull-rods.
- g). *Throttle (governor) control*: This should be adjusted so that the rated speed of the engine is achieved at the full throttle setting. Usually this is via the engine speed adjustment connected to the hand-operated control.
- h). *Wheel-track adjustment*: The wheel-track will usually be adjustable to cater for ploughing, rotary cultivation or transport. The wheel-track can be adjusted by changing the position of the wheel mounting on the axle and by interchanging the left and right wheels.
- i). *Connection of other implements*: Implements and trailers, rather than the rotary cultivator, can be hitched to the tractor via an adapter frame bolted to the rear of the tractor gearbox.

3) Draught animal power

DAP (draught animal power) can be supplied by other animals, such as equines and camelids. Proper feeding, watering and sound management are all required to keep working animals in good condition and reduce the risks of sickness. All mature animals have basic daily needs (maintenance requirements) to keep them healthy and at constant weight

The principal requirement of work animals is energy. **Working animals require about 2% of their body weight in forage per day:** for example, the daily forage requirement of a 350-kg ox is ≥ 7 kg.

The total nutritional requirements of draught animals depend not only on the work they do, but also on their stage of growth (juvenile or mature), and – for female animals – on their state of reproduction (pregnancy or milk production):

- Mature ox – maintenance and work only.
- Young male ox (2½–4 years old) – maintenance and work, plus body development.
- Cow – maintenance and work, plus reproductive functions.

For working animals to grow and work to their full potential, they must be healthy. The principal health problems requiring treatment in working animals are specific illnesses (due to disease-causing organisms), parasites, poisonings and wounds. Refer to the local veterinary services and stock owners for information on the main risks present in the area, and how to combat them. Vaccination of young animals and regular veterinary visits for all draught animals may seem costly, but the benefits in terms of animal health, and hence the ability to work, make the investment worthwhile.

Agricultural equipment for a hire service business

A range of equipment is available to service providers to perform agricultural operations. The service provider must make an informed decision about the equipment to operate, based on technical skills, demand and profitability in the local context.

Sustainable agricultural equipment for a range of power sources

When planning the types of services that a hire service business can provide, it is important to understand what is available. There are various types of equipment, depending on the agricultural operation, power source, crop and field conditions. It is fundamental to plan how to provide the service and then to select the right equipment.

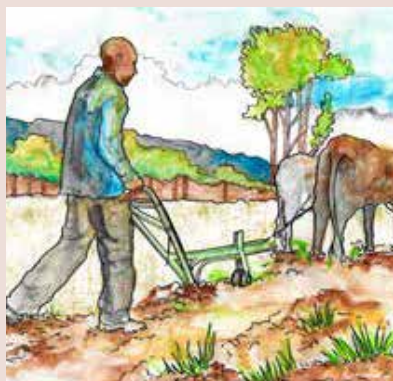
Some examples for each of the main crop operations for human, animal and engine power are presented as follows:

Land preparation

Planting stick



Animal-drawn ripper



Tractor-mounted ripper



Crop establishment

Hand jab-planter



Animal-drawn direct seeder



Tractor-mounted direct seeder



Crop management

Hand- or animal-pulled knife roller



Animal-drawn weeder



Tractor-mounted weeder



Hand-operated sprayer



Animal-drawn sprayer



Tractor-mounted sprayer



Crop harvest

Hand-guided, engine-powered reaper



Animal-drawn harvester

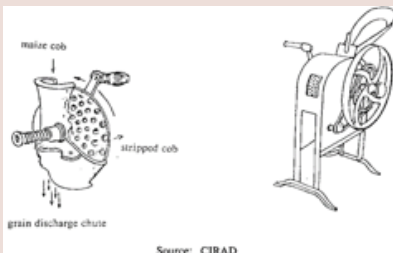


Tractor-mounted reaper



Post-harvest

Hand-powered maize Sheller



Rice mill



Cereal thresher



Source: FAO & CIMMYT, 2018

Maintenance and safe use of agricultural equipment

The routine maintenance of farm machinery is often neglected, potentially leading to expensive machine failures and machine downtime when income-earning fieldwork has to stop. A sound maintenance and servicing schedule is important to ensuring long-lasting, trouble-free and safe field operation of agricultural machines. It also enables a hire service to work more regularly and predictably, seizing new business opportunities that may arise and thus increasing revenues.

Importance of maintenance management

Good maintenance begins with good operation. Correct operation and regular maintenance are essential for the smooth running of the hire service business:

- *Fewer breakdowns.* All machines wear out. How quickly they wear out depends on how well they are operated and how well regular preventative maintenance is carried out.
- *Lower operating costs.* Carrying out regular maintenance costs money. However, the investment pays for itself many times over. A machine kept in good working order costs less to operate and there are fewer breakdowns and lower overall repair costs. Moreover, when one part fails on a machine, other associated parts may also be damaged: the owner not only has to repair the immediate breakage but also the associated damage. Breakdowns increase the risk of failing to deliver required services, resulting in financial losses for the business and tarnishing the image of the service provider.
- *Improved safety.* Badly maintained machines lead to accidents and higher costs. Correct machine operation: When a new machine is delivered, the customer should insist that the supplier provide full instructions on its operation. In addition to a comprehensive operator's manual, the customer should also receive a maintenance manual and, if possible, a spare parts manual. The operator must become familiar with the operating instructions and “respect” the machine. Never underestimate the value of a good operator.
- *Machine guarantee.* The owner needs to be aware of the guarantee period and of any obligations under the guarantee.
- *Maintenance schedules and records.* The operator and workshop must follow each machine's specific maintenance schedule, which takes the form of a checklist: what work has to be carried out, when (frequency) and the costs involved. The checklist helps ensure that all recommended service and maintenance procedures are carried out at the correct intervals.

Selecting maintenance and repair service facilities (workshops)

Research the services available to be able to make an informed decision. Ask the following questions:

- How well equipped are the workshops?
- How well trained are the mechanics?
- Where are spare parts sourced?
- How do the costs of repair and maintenance services compare with competitors?
- How far away is the service facility?
- Are mobile services available?

Storage of farm machinery

When deciding on storage for farm machines, there are two main factors to consider:

- *Cost-effectiveness* – Do the benefits of having a shelter for the tractor and machinery justify the costs?
- *Climate* – Are the climatic conditions, especially rainfall and temperature, severe enough to justify protecting the machinery

Maintenance costs

The costs of maintaining machines include oil, spare parts, shelters, and construction and maintenance of a workshop. Fixed maintenance costs refer, for example, to shelters, while variable costs refer, for example, to spare parts and lubricants. It is essential

to keep accurate records of maintenance costs so that the hire service can have a better understanding of the real costs of a machine.

Technical maintenance of tractors

a) Overview of technical maintenance for four-wheel tractors

Periodic preventative maintenance – the maintenance schedule

All of the machines owned by a hire service business should have a maintenance schedule. Preventative maintenance reduces the risk of machine failure and costly repairs.

- **Servicing the fuel system:** Dirt and water are the main enemies of diesel injection systems: it is essential to keep fuels clean. Water, even in extremely small amounts, causes corrosion of the closely fitted metal surfaces of injector pumps and nozzles. To clean fuel filters with drain plugs, loosen the plugs and drain water and dirt from the filter; then drain the filters themselves. Change fuel filter cartridges at regular intervals. Whenever fuel lines and filters are drained, air enters the system and it is necessary to “bleed” the system to expel the air
- **Servicing the air intake system:** Check dry-type air cleaners and filters with a pre-cleaner bowl every 10 hours and remove dust on a routine basis. Changing engine crankcase oil: When changing the oil and filter, ensure that the engine is warm. This enables any contaminants and foreign materials to be mixed with the oil and drained out with it. Moreover, the oil tends to have a lower viscosity at higher temperatures and it flows more easily from the engine. Replacing oil filters generally requires installing new gaskets or sealing rings: ensure that the sealing surfaces on the engine and filter are clean.
- **Servicing the cooling system:** A fluid-cooled engine operating without coolant rapidly overheats and becomes damaged. It is, therefore, vital that the operator keep an eye on the water temperature gauge. Check the coolant level every day when the engine is cold. Check regularly the radiator cap and seal, as well as any radiator hoses, for leaks. Remove any rubbish or dirt from the radiator fins or screen. Check the fan belt regularly for tension and wear.
- **Servicing the electrical system:** Keep the battery fully charged, top it up with distilled water (up to the level marks), and clean it regularly; keep the terminals tight and coated with grease. Maintenance-free batteries have a vented strip in place of individual vented filler caps; the vent strip may be removed for checking the electrolyte level and/or topping up with distilled water. The alternator normally requires little attention; however, carry out periodic inspection of the brushes for wear and tear, and check cable connections and belt tension frequently. Similarly, the starter motor needs little attention beyond periodic inspections of the brushes and cable connections. Since all bearings are sealed, there is no need for periodic lubrication.
- **Servicing the clutch and transmission:** Most modern tractors have a pre-lubricated clutch release bearing which does not require additional lubrication. However, note that free travel of the clutch pedal may require periodic adjustment.
- **Servicing the gearbox, hydraulics, differential and final drives:** These systems do not usually require a lot of maintenance. Check the oil level and change the oil at intervals, as specified in the operator’s manual.

b). Overview of technical maintenance for two-wheel tractors (2WTs)

Many of the maintenance issues outlined for 4WTs apply also to 2WTs. What is significantly different include:

- **Servicing the engine cooling system:** Most 2WT diesel engines are cooled by an evaporative system. Water is boiled in the cooling pan above the engine: replenish when the level falls below a pre-determined minimum, signalled by a float system. Use clean, soft water and

drain the system over winter if there is any danger of sub-zero temperatures and freezing. Clean the water pan and cooling channels with a weak acid solution (e.g. 25% hydrochloric acid) every 500 hours to combat possible lime-scale accumulation.

- **Adjusting the V-belt tension:** Tension is important: excessive slackness causes the belts to slip, increasing both transmission power losses and V-belt wear; on the other hand, an over-tight belt overloads transmission bearings. Achieve the correct adjustment by sliding the engine forwards or backwards on the tractor chassis.
- **Adjusting the transmission clutch:** Adjust the clearance between the clutch engagement lever and clutch bearing (using a feeler gauge) using the adjusting and locking nuts. Adjust the clutch–brake system in a similar way with free play eliminated (or reduced to an acceptable level) by adjusting the length of the pull-rod. Similarly, adjust the braking system by varying the length of the pull-rod to eliminate excessive play.
- **Adjusting the steering system dog clutches:** Eliminate play in the system by adjusting the lengths of the steering pull-rods.
- **Adjusting the throttle (governor) control:** Adjust the throttle control in order to achieve the rated speed of the engine at the full throttle setting. Usually this is via the engine speed adjustment connected to the hand-operated control.
- **Adjusting the wheel-track:** The wheel-track is usually adjustable to cater for ploughing, rotary cultivation or transport. Adjust the wheel-track by changing the position of the wheel mounting on the axle and by interchanging the left and right wheels.
- **Checking the transmission:** Change the transmission oil after 500 hours. Check regularly (weekly) transmission oil levels using the oil level inspection cap; replenish as necessary. Adjust the built-in chain tensioner to achieve the transmission drive chain tension (if incorporated); adjust when excessive noise indicates slackness.

Safety in the use of machinery and equipment (tractors and sprayers)

Safety in the operation of agricultural equipment is critical. The safe operation of tractors, both 2WTs and 4WTs, is vital for the security of both the operator and others. It is essential to follow the safety instructions in the operator's manual and heed safety warnings on the machine itself at all times.

Safety advice on 2WT use:

- Never attempt maintenance adjustments on the tractor with the engine running. Rotating parts (e.g. V-belts and pulleys) are particular danger points.
- Keep all guards in place and avoid loose clothing that could catch in moving parts.
- Keep onlookers (especially children) at a safe distance to avoid injury from flying debris
- Take extra care on sloping ground. Use a low gear and low speed. Always keep the transmission in gear and never attempt to change gear on the move.
- Stay clear of the hot exhaust pipe or radiator.
- Make sure that the gear lever is in neutral before cranking the engine.
- Never attempt sudden turns with the steering clutches at high forward speed; slow down first.

Safety advice on sprayers use

Working with sprayers requires certain safety measures in order to ensure that occupational health is not under threat. The following are among the basic requirements:

- Use protective clothing to protect the operator from contact with agrochemicals.
- Wash your hands, face, body and spray equipment immediately after handling or using any agrochemical.

- Rinse and clean spray equipment well away from water sources such as wells, ponds or rivers.
- Always store agrochemicals in their original containers, well out of reach of children and animals.
- Dispose of containers in a deep pit, or as indicated by the manufacturer.

Sprayers require regular maintenance to ensure efficiency. Basic maintenance entails the following:

- Ensure that the equipment is in good working condition (no leaks or blockages).
- Check that the valves and switches are working properly and that the spray nozzles and filters are not worn or clogged. Replace worn-out or defective parts immediately.
- Clean the equipment immediately after use.
- Lubricate moving parts as indicated in the operator's manual.
- Regularly check for, and tighten, any loose bolts and nuts.

Calibration of Planters and Seeders

To meet the requirements of clients and enable their own businesses to grow, service providers must apply the correct amount of seed and fertilizer per hectare at the required spacing. To achieve this, it is necessary to calibrate planters and sprayers. There follows a summary of calibration procedures that are effective and easy to perform with a minimum of equipment. Equipment must be calibrated every time before use

Jab Planters

It is usually possible to adjust manually operated jab planters and regulate the number of seeds delivered per planting station and the amount of fertilizer delivered at the same time. Metering mechanism varies between different makes of jab planters, and it is important to follow the operator's instructions. For seeds, for example, there may be a simple sliding shutter that varies the size of the seed cell, or a rotating circular seed disc could need changing to one suited to the size of seed.

- Inspect the main features of the jab planter, paying particular attention to the seed and fertilizer metering mechanisms.
- Adjust the seed metering mechanism to give a range of seeds per hill and calculate the seed rates per hectare.
- Adjust the fertilizer metering mechanism to give a range of application rates.

To calculate seed and fertilizer rates per hectare, first determine the distance between planting stations along the row and the distance between rows.

Animal- or Tractor-Drawn Planters

The seed and fertilizer metering mechanisms on these planters are usually operated by a ground-drive wheel and the procedure for calibration is as follows:

- Calculate the circumference of the drive wheel (Circumference = $\pi \times$ wheel diameter; $C = \pi \times D$).
- Raise the metering wheel and rotate for (say) 10 revolutions. Collect the seed delivered in a suitable container (Plate 4.10).
- For large seeds, the distance between plants is calculated as follows:

$$\text{Distance between Seeds (cm)} = \frac{\text{Wheel Circumference, } C \text{ (cm)} \times \text{No.Revs}}{\text{No.Seed Dropped}}$$

- For all seeds, the metered amount can be weighed and the application rate per hectare calculated as follows:

$$\text{Seed rate (kg/ha)} = \frac{\text{Weight of seed delivered (kg)} \times 10,000}{C \text{ (cm)} \times \text{No.Revs} \times \text{Row Spacing (cm)}}$$

- Repeat the calibration at least three times for each transmission setting.
- The procedure is the same to calculate fertilizer application rates per hectare.

Calibration of Sprayers

Without calibration, it is not possible to predict the rates per hectare of agrochemical applications. Therefore, to meet the client requirements, the service provider must be sure that the correct doses of pesticide or herbicide are applied uniformly across their fields. It is, therefore, essential that sprayers are well-calibrated.

Backpack (Knapsack) Sprayers

- Completely fill the sprayer with water and weigh it.
- Mark out an area of, say 100 m², and spray it at normal working speed and height.
- Re-weigh the sprayer and calculate the amount of spray applied (remember that 1 litre of water weighs 1 kg).
- Calculate the application rate per hectare by multiplying the applied volume by 100.

Multi-Nozzle Sprayers pulled by a Person, Draught Animal or Tractor

To calibrate the sprayer, while checking that the nozzles are in good condition with uniform delivery of liquid, follow the steps below:

- Mark out a track (e.g. length 25 m) and calculate the sprayer working width (number of nozzles × inter-nozzle distance).
- Collect the output of the sprayer over the track by holding calibrated containers under each nozzle.
- Calculate the application rate as follows:
- Repeat the test at least three times and calculate an average application rate.
- Calculate the equivalent number of spray tanks applied per hectare; then calculate the amount of chemical to be added to each tank. For example, if 5 tanks of 20 litres (i.e. 100 litres) are applied per hectare and it is necessary to apply, for example, 4 litres of agrochemical per hectare, each tankful must contain 0.8 litres of chemical.

Technical Performance of Equipment: Shellers and Threshers

Threshing and shelling are key post-harvest requirements: they help farmers reduce crop losses and ensure that clean grain is ready to be safely stored. It is an increasingly popular operation among service providers (especially in sub-Saharan Africa) where motorized threshers in a range of sizes are used.

There are three main operations involved in the threshing or shelling of grains using machines:

- Separation of grains from the ear, cob, shell or panicle.
- Separation of grains from the grain and chaff/straw mixture.

- Winnowing to remove chaff and leave the clean grain ready for collection.

A wide range of shellers and threshers are available in the market today, both manual and engine-powered. Shellers and threshers are categorized according to the power source used and the types of crops handled. Manual threshers are normally operated using hand or foot pedals; power shellers and threshers are operated using a diesel or petrol engine or an electric motor.

Repair, maintenance and safe use

To offer a reliable service and give the best performance in terms of grain quality, operator safety and profitability for the service provider, shellers and threshers require proper maintenance according to the manufacturer's instructions. With regular maintenance, it is possible to:

- avoid grain contamination through oil leaks and metal breakages;
- provide a reliable service resulting in satisfied customers;
- minimize the risk of extensive repairs due to poor maintenance;
- help ensure that the machine works effectively and safely; and
- prolong the working life of the thresher.

Technical Performance of Equipment: Pumps

Two-wheel (and four-wheel) tractors can be used to power pumps and may be employed by a service provider to supply pumping services to farmers. The most frequent use is for crop irrigation, but other applications exist.

Two-wheel tractors can be coupled to various types of water pumps (including axial-flow propeller pumps and centrifugal, or volute, pumps). The pumps can be driven either via a transmission belt from a pulley driven by the 2WT engine, or directly via a power-take-off shaft from the tractor's transmission. The output of a pump varies according to the suction and discharge heads.

The performance curve of a pump varies depending on the type of pump. For example, axial flow pumps can only work with low heads, but can move large volumes of water at surface level; on the other hand, centrifugal pumps, can suck water from deeper heads and pump it to higher heads, but they deliver lower volumes than an axial pump of similar power (they are, therefore, suitable for deep wells or for pumping at locations such as terraces that are higher than 5 m from the water level).

Safe Pump Operation

The following checklist is for guidance on safe and efficient pump operation. Before the practical exercise, participants run through these points under the guidance of the trainer.

Checklist for safe pump operation

1. Check all bolts and junctions.
2. Check for holes in the pump body.
3. Check the greasing of the bushings.
4. Clear the inlet of the pump from any obstructions.
5. Check the level of oil and fuel in the engine.
6. Check the belts for cracks or damage.
7. Set up the belts.
8. Ensure that the belts or PTO are correctly aligned with the pump.
9. Ensure that the pump is not touching the bottom of the river or canal, and that it is not above the water surface.
10. Check that both the engine and the pump are securely fastened to the ground or 2WT, to ensure they do not move during operation.



4.5.3. Learning activities and/or exercises

Learning Exercise 4.1: Enhance participants understanding on the basic technical components of the power course options

Objective: To introduce to the participants the basic technical components of the power source options and become familiar with their main systems and characteristic

Materials required: tractor/tractor engine, handouts, Pens and notebooks

Method:

1. Assemble the participants accordingly
2. Provide each participant with a pen and a notebook
3. Distribute handouts with the overview of main systems of four-wheel tractors
4. Present a disassembled tractor
5. Give participants time to study the handout
6. Form three groups to focus on specific systems as indicated below. Ask each group, with the help of skilled mechanics and the operator's manual, to discuss, identify and practise the key functions of the following groups of systems:
 - Group 1. Fuel, air intake and exhaust.
 - Group 2. Lubrication, cooling and electrical.
 - Group 3. Transmission, hydraulics and clutch.
7. Ask each group to explain the procedures, by demonstration, to the other groups.
8. Summarize the key points or emerging issues from the discussion from each of the issues systems above

Learning Exercise 4.2: Widen participants understanding on available equipment options for agricultural hire services for SAM options

Objective: To create awareness to the participants on the available equipment options for agricultural hire services offering sustainable production intensification options.

Materials required:

Video screen and player (or Laptop and projector with screen), selected videos (links), Handout on Sustainable agricultural equipment for a range of power sources, Pens and notebooks

Method:

1. Assemble the participants accordingly
2. Provide each participant with a pen and a notebook
3. Play the different selected videos focused on introducing the different types of equipment that can be used from land preparation to harvest with the different power options:

Jab/hand planters:

- <https://www.youtube.com/watch?v=SnnYuZ-K6NU>
- http://av.voanews.com/Videoroot/Archive/kaltura-test/VOA/VOA_-_English/mp4/2013/08/0_o50fblxs_l_q0yo0tyz.mp4

Animal-drawn planters:

- <https://www.youtube.com/watch?v=hU3NqITKtBo>
- <https://www.youtube.com/watch?v=U6aOnQiiIFU>

Direct seeding planters:

- <https://www.youtube.com/watch?v=m3eEqIBDXjg>
- https://www.youtube.com/watch?v=YPu_3qKif7E
- <https://www.youtube.com/watch?v=Q7Ej20NzZ28>
- <https://www.youtube.com/watch?v=togiZfnfsnk&feature=youtu.be>

Maize sheller:

- <https://www.youtube.com/watch?v=ekzF6v7I230>
4. After each video, foster discussion, underlining the main messages of the video while encouraging participants to share their own views and experiences.
 5. Ask participants to identify the main points and discuss the following questions:
 - What are the current types of equipment used in the area for sustainable agricultural production?
 - Which of the proposed/displayed equipment may have potential for the hire services considering the agronomic and socio-economic conditions of the participants' (and clients') areas of work? Give reasons for the choices suggested.
 6. Summarize the discussion notes for each of the issues above.

Learning Exercise 4.3: Basic introduction to the concepts of safety, maintenance and operation of four-wheel tractors and their associated implements

Objective: To introduce to the participants the concepts of safety, maintenance and operation of four-wheel tractors and their associated implements for agricultural hire services

Materials required:

Video screen and player (or Laptop and projector with screen), selected videos (links), Handout on importance of maintenance management, Pens and notebooks

Method:

1. Assemble the participants accordingly
2. Provide each participant with a pen and a notebook
3. Play the following selected videos on how to operate a four-wheel tractor
 - Part 1 (duration 1.52). Safety checks. Available at: <https://www.youtube.com/watch?v=PtF2YZTVFYg>
 - Part 2 (duration 3.08). Pre-start checks. Available at: <https://www.youtube.com/watch?v=AVyh92Ongml>
 - Part 3 (duration 4.15). How to operate tractor. Available at: <https://www.youtube.com/watch?v=OGexMtCf-AQ>
 - Part 4 (duration 10.20). How to operate tractor attachments? Available at: <https://www.youtube.com/watch?v=8TEfjLpLNYE>
4. After each video, ask participants what the main points are and encourage discussion and sharing of personal experiences
5. After each video, foster discussion, underlining the main messages of the video while encouraging participants to share their views and experiences.
6. Besides, ask participants to discuss the following questions:
 - Why is regular machinery maintenance important?
 - What are the costs and losses in revenues related to not maintaining machinery?
 - What are the most important maintenance activities for tractors and other important agricultural machines in use in the region?
 - What criteria should be applied when selecting a machinery dealer and repair workshop?
 - Would it be cost-effective to invest in your workshop for machinery servicing?
7. Summarize the discussion notes for each of the issues above.

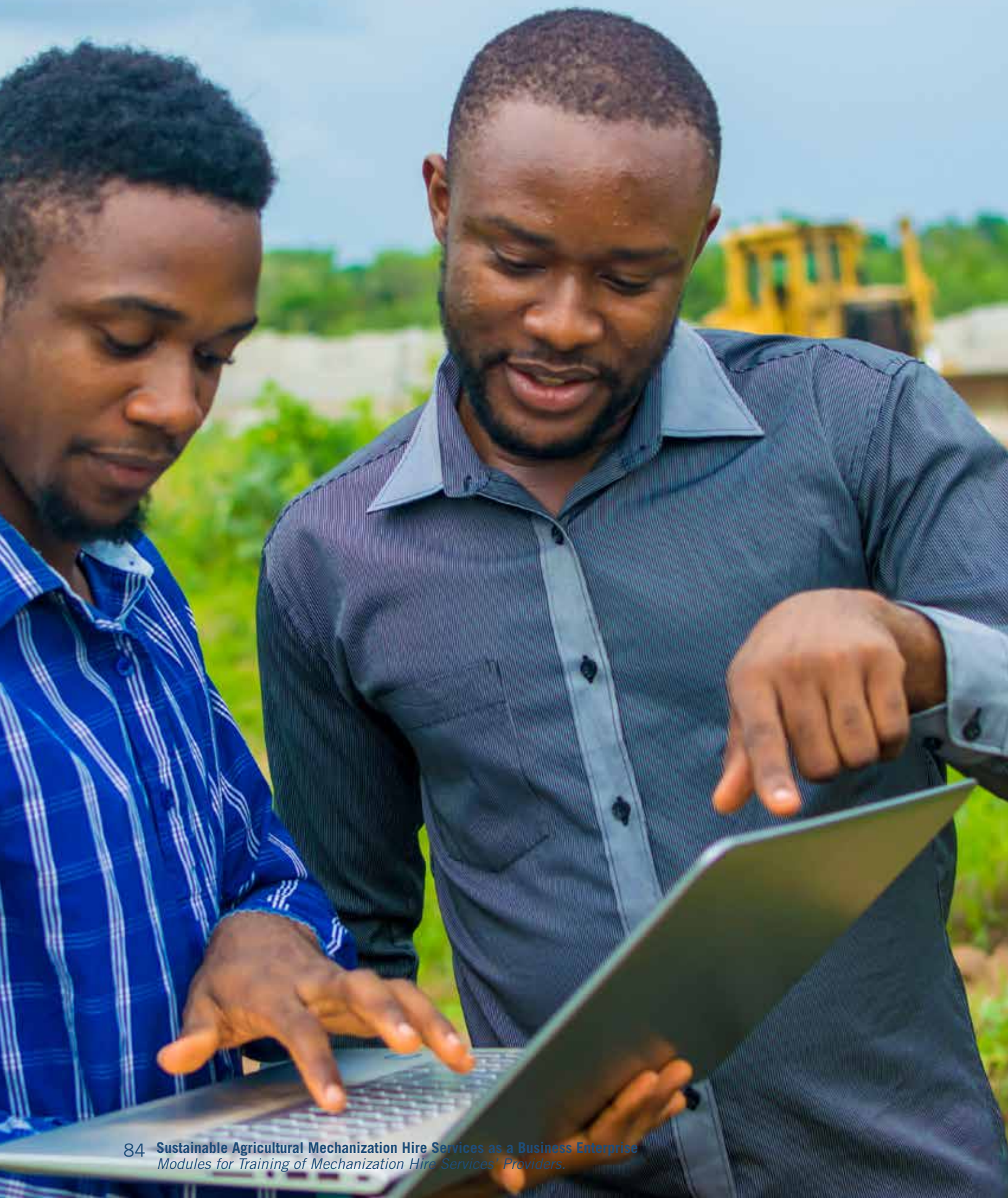
4.5.4. Review questions

- a). Why is regular machinery maintenance important?
- b). What are the costs and losses in revenues related to not maintaining machinery?
- c). What are the most important maintenance activities for tractors and other important agricultural machines in use in the region?
- d). What criteria should be applied when selecting a machinery dealer and repair workshop?
- e). Would it be cost-effective to invest in your own workshop for machinery servicing?
- f). Which are the main activities commonly conducted by the tractor owners and why?
- g). What are the possible reasons for high operating costs for the tractor owners?
- h). Mention several factors for selection of areas for hire business.
- i). What requirements are needed for management of farming equipment for hiring a business
- j). Is it possible to form a Tractors Owners & Hiring Facilities Association?
- k). How do they plan on the provision of service and customer satisfaction?
- l). How do you develop the Financial plan?
- m). How do they access for the provision of hiring services?
- n). Is there any participant with personal experience, or knowledge of health and safety issues related to the use of tractors and agricultural equipment? If so, describe the situation and the consequences. What could have been done to avoid the situation?
- o). Are there sprayer owners or operators among the participants? Or do the participants know a sprayer operator or owner? Do they regularly have access to and use protective clothing? If not, why not?

4.5.5. Sources of additional/further reading/reference materials

Recommended background reading: Share with participants any readings you feel may be useful. The publications listed below are freely available online

- FAO & CIMMYT. 2018. Hire services as a business enterprise. A training manual for small-scale mechanization service providers. Food and Agriculture Organization of the United Nations (FAO), International Maize and Wheat Improvement Center (CIMMYT), Rome, Italy. 127p. Available at: <http://www.fao.org/3/I9207EN/i9207en.pdf> (Page 61 - 97).
- FAO & AUC. 2018. Sustainable Agricultural Mechanization: A Framework for Africa. Addis Ababa. 127pp. Licence: CC BY-NC-SA 3.0 IGO
- IIRR and ACT. 2005. Conservation Agriculture: A manual for farmers and extension workers in Africa. International Institute of Rural Reconstruction, Nairobi; African Conservation Tillage Network, Nairobi. ISBN 9966-9705-9-2. Available at http://act-africa.org/lib.php?com=5&com2=20&com3=38&res_id=191
- FAO. 1994. Testing and evaluation of agricultural machinery and equipment: Principles and practices. FAO Agricultural Services Bulletin 110. Available at: <http://www.fao.org/3/a-t1841e.pdf> (Test procedures for tractors and a wide range of agricultural machinery)



MODULE 6: MANAGING THE HIRE SERVICE AS A BUSINESS

4.6.1. Introduction

Managing a hire service involves diagnosis, planning, organization, leadership and control – running the business and its services in a way that is environmentally friendly.

This module covers four basic areas in four separate sessions:

- Entrepreneurship and management in the hire service business. This session provides an overview of hire service business management and shows the importance of ensuring that the business is managed in an “environmentally friendly way”. It presents the concept of risk in business and how to deal with it. Reference is also made to the specific management topics covered in the module: business organization, business operations and finance.

Hire service business organization. This session covers the business organization of a hire service – how the hire service is set up as a business – with regard to location, ownership, assets, staff management, and supplier and customer relations.

- Managing hire service business operations. Managing the operations of a hire service means dealing with all the tasks and activities required to run the business and provide services. This involves diagnosing, planning, organizing, leading and controlling all the components that make up the operations of the hire service business.
- Managing financial aspects of the hire service business. It involves planning, organization and coordination, leadership, and the ability to control money. Financial management includes generating profit for the business, obtaining funds, ordering machinery and equipment to the best advantage, keeping assets in good working order, ensuring adequate cash flow for ongoing activities, and in the long term, achieving business growth. The hire service manager needs to make good financial decisions. Some aspects of finance are covered in Module 3, including cash flow, investment in machinery and loan appraisal. This session examines financial management more broadly and covers the following topics: Assessing the profitability of the business; Calculating hire charge rates; and Preparing a business plan.

Learning objectives



Learning objectives

At the end of the module the learner /trainee should be able to:

- Understand the concepts of entrepreneurship and management.
- Understand the importance of managing a hire service as a business.
- Describe managing a hire service in terms of business organization, operations and finance.
- Demonstrate how to manage a hire service as a business.

Materials	
	Laptops, overhead projectors; power point projectors, handouts, posters, fact sheets, training manual, flip charts, writing pads, note books, pens, pencils, masking tape and marker pens.
Training Methodology	
	<ul style="list-style-type: none"> • Facilitation (plenary presentation by facilitator, group discussion, plenary presentation and discussion of group work) • Demonstrations, charts, visual aids /posters • Learning Exercises to enable the participants to share new ideas and experiences and to review and revise the various topics presented. Various case studies may also be introduced to broaden the scope of learning. • Practical or field trips to enable the participants to learn practically the operation, adjustments, maintenance and management of different machines and implements.
Duration:	
	2 hours

4.6.2. Key concepts and discussions points

Introduce to the learners the following key concepts and discussion points as you lead the training. Open up for discussion as much as possible and ask as many questions as you can.

These key concepts and discussion points necessary to introduce the module and enhance the understanding of the participants in the subject matter are as follows:

Entrepreneurship and management in the hire service business.

This session provides an overview of hire service business management and shows the importance of ensuring that the business is managed in an “environmentally friendly way”. It presents the concept of risk in business and how to deal with it. Reference is also made to the specific management topics covered in the module: business organization, business operations and finance.

Hire service business organization.

This session covers the business organization of a hire service – how the hire service is set up as a business – with regard to location, ownership, assets, staff management, and supplier and customer relations.

Managing hire service business operations.

Managing the operations of a hire service means dealing with all the tasks and activities required to run the business and provide services. This involves diagnosing, planning, organizing, leading and controlling all the components that make up the operations of the hire service business.

Managing financial aspects of the hire service business.

It involves planning, organization and coordination, leadership, and the ability to control money. Financial management includes generating profit for the business, obtaining funds, ordering

machinery and equipment to the best advantage, keeping assets in good working order, ensuring adequate cash flow for ongoing activities, and in the long term, achieving business growth. The hire service manager needs to make good financial decisions. Some aspects of finance are covered in Module 3, including cash flow, investment in machinery and loan appraisal. This session examines financial management more broadly and covers the following topics: Assessing the profitability of the business; Calculating hire charge rates; and Preparing a business plan.

4.6.3. Learning activities and/or exercises

Learning Exercise 6.1: Sharing hire service managerial experiences

This practical learning exercise is designed to enable participants to understand what management is, the skills it requires and the essential ingredients of management in a hire service business.

Invite presenters with experience in managing a hire service business to provide a brief presentation, followed by a question and answer session. Facilitate discussion between participants and presenters and encourage participants to take notes on the main points of the discussions. Ensure that the main points are recorded and made available to all participants.

Learning Exercise 6.2. What is management in a hire service business?

Organize participants into groups, distribute Handout 5.1.1, and ask them to read and discuss it. Encourage and facilitate discussion and debate, and ask the following questions:

- What are the characteristics of entrepreneurs?
- How would you define management in a hire service business?
- What skills are involved in managing a hire service and why do you think these skills are important?
- Why is good management important?
- What do you think are the greatest challenges involved in management?
- Why is it important to manage a hire service in an environmentally sustainable way?
- What are the major risks that could affect your business?
- What is their likelihood and possible impact? How can you handle these risks?

Exercise 3. Managing the hire service business organization

Organize participants into groups, distribute Handout 5.2.1 and ask them to read it. Encourage and facilitate discussions and ask the following questions:

- What are the main organizational aspects of the hire service business?
- Why is it important to manage these aspects of the hire service business effectively?

Exercise 4. Setting up a hire service business

Note to the trainer: Begin the exercise with a plenary discussion about the hire service business in general. The following questions could be used to guide the discussion:

- Why do people start businesses?
- Why do you want to start a business?
- What are the benefits and costs?
- Why do businesses fail?
- What are the risks in setting up the business?
- How can you deal with risks?
- What impact will your business have on the community and the natural environment?
- How important is it to be environmentally sustainable?
- How can you make your business environmentally sustainable?

Divide participants into groups (of about five). Each group should decide on a particular hire service business. This may be based on their own experiences or on a business with which some of the group are familiar. If the group cannot agree on a single business or prefer to select two businesses, let them divide into subgroups.

Each group should describe the background to the service they selected, answering the following questions:

- Where is the hire service located?
- What is the local farming system?
- What assets do you have?
- What form of organization is it? (e.g. sole proprietorship, partnership, group enterprise, fulltime/ part-time business).

Ask the groups to plan the organization of their business by answering the following questions:

Organization:

- Why did you decide on your organizational model (sole owner–operator, partnership, group)? What are the advantages/disadvantages?
- Is it better to be part of a formal partnership or to form a partnership only for buying equipment and/or selling services?
- Is it beneficial to enter a partnership with an equipment dealer?
- What do you have to consider before going into a partnership?
- What are the pros and cons?
- Should you work as a full-time or part-time business? What are the pros and cons?

Services and customer relations:

- Who is your business going to sell services to?
- Will you only try to sell to a specific type of customer or to everyone in an area?
- What services are your customers likely to need?
- What services will you offer?
- How is your business going to sell these services?

Stakeholder partnerships and support services:

- What contacts do you need with other stakeholders?
- Which are most important? How will you develop good relations?
- What external services are needed to support your business? How will you develop these relations?

Asset requirements:

- What assets/machinery does the business need?
- What is the likely cost? How will you afford to buy the machinery and other assets?
- What office/storage space are you likely to need?
- What should be the legal status?

Registration/legal status:

- Should it be a registered business? What are the pros and cons?
- What is required to register the business? Is a licence required? What does it cost? What are the legal requirements in terms of ownership, safety, insurance, taxes and employing staff?

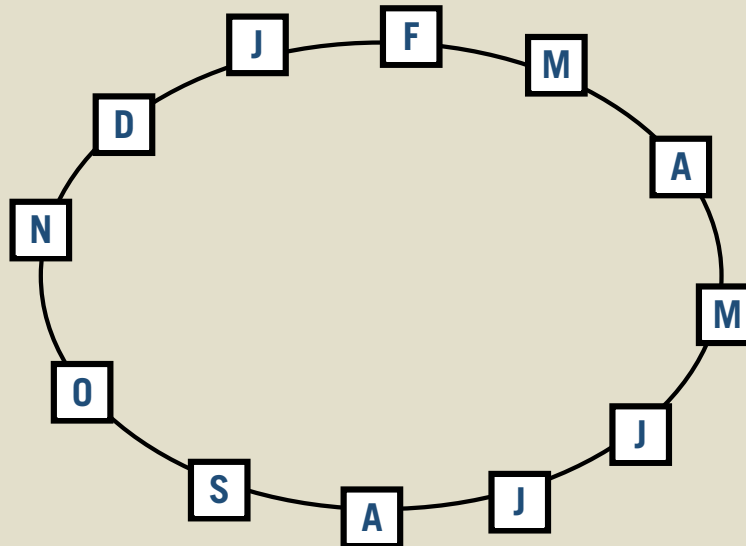
Staff:

- What staff do you need to employ? (full-time or temporary)
- What work will they do?
- Can the hire service business afford to employ fulltime staff?
- What training is needed? What are the laws on hiring staff? What are the safety requirements?
- What incentives can you offer to improve performance?

Ask the groups if there are other considerations that they should take into account. Ensure that each group has sufficient time to present their business to the plenary. Encourage the group members to challenge the presenter by asking probing questions, demanding clarity and suggesting improvements.

Exercise 5. Calendar of work and tractor use plan

1. Let the participants sit in the following arrangement.



2. Participants are organized in twelve pairs and the first pairs placed on the month following the training programme and the last pairs participants placed at the end of the year.
3. The pairs are positioned in a circle keeping twelve positions (representing the twelve months in a year) as shown in the picture above. Where appropriate, some positions can be taken by one participant.
4. Ask each pair of participant to mention the respective key features of the particular month.
5. Let the group identify specific seasonal activities related to machinery hire service.
6. Have a brief intermediate processing after each round which should focus on different mechanization activities. Inquire if they were aware of seasonal machinery operations. What would this mean to their businesses in terms of different machinery? Ask the other participants for their observations!

Exercise 6. Calendar of work and tractor use plan

1. Get the participants to form groups. Each group should represent a different hire service operation
2. Each group should brainstorm the information that they require to plan their mechanization operations throughout the year.
3. Each group should estimate customer demand preparing a mechanization plan as presented in Handout above for their selected machinery operation to be performed.
4. Ask each group estimated total operational month, week day and hours for each hire services?
5. As the group how they can deal when there is unmet demand with their current capacity or number of machinery or labour?
6. Get each group should present back to the plenary. Initiate a plenary discussion.

4.6.4. Suggested background reading:

The reference material listed is recommended for you, the trainer; share with participants as appropriate. The publications below are freely available online:

FAO. 2012. *Hire services by farmers for farmers*. B. Sims, A. Rottger & S. Mkomwa. Rome. Available at: <http://www.fao.org/3/a-i2475e.pdf>.

FAO. 2009. *Rural transport and traction enterprises for improved livelihoods*. P. Crossley, T. Chamen & J. Kienzie. Rome. Available at: <http://www.fao.org/3/a-i0525e.pdf>.

FAO. 2009. *Explaining the finances of machinery ownership*, J. Heney. Rome. Available at: http://www.ruralfinanceandinvestment.org/sites/default/files/1257513712522_TAM3_final_lowres.pdf.

FAO. 2009. *Explaining profitability and borrowing*. J. Heney. Rome. Available at: http://www.ruralfinanceandinvestment.org/sites/default/files/1257513437786_TAM2_final_lowres.pdf.

FAO. 2005. *Explaining cash flow and savings*, J. Heney, Rome. Available at:

http://www.ruralfinanceandinvestment.org/sites/default/files/1136798915189_TAM_1_edited_Jan06.pdf.

Annex 1: Monthly Cash Flow for Hire Service Provision in Matui village Kiteto District

Activity	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Total
Sales of Services													
Ripping	3,000,000	6,000,000	4,500,000	7,500,000	3,000,000								9,000,000
Ploughing			5,250,000	3,500,000	1,750,000								15,000,000
D/Seeding						6,000,000	6,000,000						10,500,000
Puddling													12,000,000
Haulage							300,000	600,000	600,000	900,000	1,200,000	900,000	4,500,000
Total	3,000,000	6,000,000	9,750,000	11,000,000	4,750,000	6,000,000	6,300,000	600,000	600,000	900,000	1,200,000	900,000	51,000,000
Fuel	660,000	1,320,000	2,640,000	3,410,000	1,430,000	1,320,000	1,364,000	88,000	88,000	132,000	176,000	132,000	12,760,000
Lubricants	66,000	132,000	264,000	341,000	143,000	132,000	136,400	8,800	8,800	13,200	17,600	13,200	1,276,000
Operator	500,000	1,000,000	1,500,000	1,750,000	750,000	500,000	550,000	100,000	100,000	150,000	200,000	150,000	7,250,000
Repair & Maint	190,000	380,000	585,000	615,000	270,000	240,000	266,000	52,000	52,000	78,000	104,000	78,000	2,910,000
Total	1,416,000	2,832,000	4,989,000	6,116,000	2,593,000	2,192,000	2,316,400	248,800	248,800	373,200	497,600	373,200	24,196,000
Net Cash Flow	1,584,000	3,168,000	4,761,000	4,884,000	2,157,000	3,808,000	3,983,600	351,200	351,200	526,800	702,400	526,800	26,804,000
Cumulative Net Cash Flow	974,000	4,142,000	8,903,000	13,787,000	15,944,000	19,752,000	23,735,600	24,086,800	24,438,000	24,964,800	25,667,200	26,194,000	

Annex 2: Investors in Mechanization Hire Services Provision Training

Sample One - Day Training Programme for Machinery Owners and Managers

Date: Monday, 16th November 2020

Venue: Virtual – online

Target: Investors (machinery owners, managers, dealers, financiers and off-takers)

Training outputs:

1. Awareness created on the opportunities offered by agricultural mechanization and SAM hire service provision and how a farm mechanization service enterprise operates.
2. Ability by tractor owners and MSPs to make better and informed use of Conservation Agriculture for enhancing commercial, environmental and socio-economic sustainability.
3. Identify SAM opportunities in the local area and facilitate linkages to machinery, financial products and access to information & technologies.
4. Ability to select appropriate equipment according to desired technical and financial criteria.
5. Practical information sharing, networking and partnership modalities amongst tractor owners and operators initiated.

Time	Activity	Lead
08.40 – 09.00	Welcome remarks, introductions, objectives of the training and expectations.	ACT
09.00 – 09.15	Official opening (15 min)	
09.15 – 10.30	Key note presentation: Introduction to Hire Services as a Business Enterprise. <i>Keynote presentation (15 min)</i> Panel Discussion: Thematic Panellists (30 min) <ul style="list-style-type: none"> • Value chain investors/contract farming • Machinery supplier/dealer, Repair & maintenance • Financial Institutions • Training of MSPs & Farmers <i>Plenary discussion (30 min)</i>	ACT Private sector Private sector Finance institution Training institution
10.30 – 10.45	Health Break	All
10.45 – 11.45	Highlight of what is contained in the MSP Training Course. Plenary presentations by Module panellists (7 min each) <ul style="list-style-type: none"> • Module 2: Conservation Agriculture • Module 3: Understanding the production environment and market • Module 4: Selecting appropriate machinery • Module 5: Operation and maintenance of agricultural equipment for hire service businesses • Module 6: Managing the hire service as a business 	Module developers
11.45 – 12.05	Knowledge & information management, networking & linkages <ul style="list-style-type: none"> • Knowledge and Information Management, Networking and Linkages: <i>Africa-Mechanise Platform</i> • Replace with: Machinery monitoring and efficient management using digitalization gadgets 	Philip Wanjohi Tony Tsalwa
12.05 – 12.35	Plenary discussion and business linkages of MSPs to Investors. <i>Plenary discussion</i>	Facilitator
12.35 – 12.50	Way forward opportunities. <i>Plenary session</i>	Facilitator
12.50 – 13.00	Closure	ACT

Annex 3: Mechanization Hire Services Providers Training

Sample Three -Day Training Programme for Operators

Target: Machinery Operators

Time	Day I	Virtual/ Online
	Activity	Responsibility
08.30 – 08.45	Welcome remarks, introductions, objectives of the training and expectations.	
08.45 – 09.00	Official opening	
09.00 – 09.30	Module 1: Introduction to Hire Services as a Business Enterprise. <i>Plenary presentation</i>	
09.30 - 10.00	Module 3: Understanding the local production environment area and market. <i>Plenary presentation</i>	
10.00 - 10.30	Plenary facilitated discussions of modules 1 & 3	Facilitator
10.30 - 10.45	Health Break	
10.45 - 11.15	Module 2: Introduction to Conservation Agriculture: concept, principles, benefits and challenges <i>Plenary presentation (30 min); demo /videos (15 min).</i>	
11.15 - 12.00	Plenary facilitated discussions of module 2	Facilitator
12.00	End of Day I	
Time	Day 2: Rapporteurs 2 – Volunteers from Participants	Virtual/ Online
08.30 - 09.00	Module 4: Operation & maintenance of agricultural equipment for hire service businesses <i>Plenary presentation</i>	
09.00 – 09.30	Module 5: Selecting appropriate machinery: technical and financial aspects. <i>Plenary presentation (including videos - 30 min)</i>	
09.30 – 10.00	Plenary facilitated discussions of modules 4 & 5	Facilitator
10.00 – 10.15	Health Break	
10.15 – 10.45	Module 6: Managing hire services as a business <i>Plenary presentations (30 min)</i>	
10.45 – 11.15	Knowledge and Information Management, Networking and Linkages: <i>Africa-Mechanise Platform</i>	Philip Wanjohi
11.15 – 11.30	Machinery monitoring and efficient management using digitalization gadgets	Tony Tsalwa
11.30 – 12.00	Plenary facilitated discussions of Module 6, KIM & networking and machinery digitalization	Facilitator
12.00	End of Day II	
	Day 3	Practical & Livestream
10.00 – 12.00	Digitalised Machinery Monitoring and Linkages to Clients and Services <i>Field practical</i>	Infogen & Country Host
12.00	Closure	





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Tillage Network

