Ethiopian ATI
Agricultural Transformation Institute
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FARM MACHINERY HIRE SERVICE BUSINESS

TRAINING COURSE FOR YOUTH AGRI-ENTREPRENEURS

Ethiopian Agricultural Transformation Institute

ADDIS ABABA, ETHIOPIA
2025

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CONTENT

OVERVIEW OF THE MODULE

This Module is designed to provide Farm machinery hire service providers, whether already in the business or intending to start new hire service business, with skills and competencies in both the technical and the management aspects of starting and running small-scale mechanization hiring business.
The Module is developed around the concept of experiential learning. Trainers present the material, lead discussions, and facilitate classroom and field exercises. During field exercises participants report the lessons learned in the field during the subsequent training meeting. This dynamic process encourages horizontal learning, in addition to input from the trainer, making the training content immediately relevant in the workplace (FAO and CIMMYT, 2018)

The material includes Sections covering the following topics:

1. Section 1 is an introduction to, and overview of, a mechanization hire service as a business enterprise.
2. Section 2 explores the means of assessing the state of the local agro-system and the potential market for mechanization service provision.
3. Section 3 focuses on the technical and financial aspects of selection and management of farm machinery.

The Agriculture-focused Dignified Employment for Youth (ADEY) program is implemented by the Ethiopian Agricultural Transformation Institute in partnership with the Mastercard Foundation to enable 611,343 inclusive and dignified work opportunities for young women and men and support youth entrepreneurship, employability, and sustainable livelihoods in the agribusiness sector.

INTRODUCTION

Hiring services in Agricultural Mechanization is an important tool for creating a batter access for advanced machinery for resource poor farmers. It has also been instrumental for establishing a business which generates decent incomes for service providers. Agricultural Mechanization lends itself for creating business opportunities in different ways. Giving machinery hire services in various production stages is one of the many approaches for rural businessmen or businesswomen to get engaged in highly productive and well-paying service provision business. However, understanding the basic concepts of machinery management is vital for establishing viable hire service provision business. Potential Service Providers (SP) should be able to analyze how, when, and where to establish the enterprise, be able to evaluate how the business performs, and identify ways for better performance and business improvement.

Most hire service providers may lack knowledge or training in understanding and critically evaluating existing business environments. Besides, they usually lack properly identify and select appropriate farm machineries, follow correct procedures in handling of mechanization technologies, and the management of their businesses. This Module is intended to fill such gaps; provide trainees with concepts covering the basic principles of identifying suitable markets, and selection, use and management of mechanization as a business. This training is to be given in conjunction with other soft skill trainings in business model, entrepreneurship, business plan development, and marketing areas.

Target Participants

This course is designed for a range of stakeholders interested in agricultural mechanization and the basics of running a hire service business. More specifically, the course is targeted towards:

- Smallholder farmers and rural youth interested in mechanization hire service provision.
- Existing or new mechanization hire service providers along the food value chain.
- Mechanization and agri-business specialists and training institutions in mechanization service provision

SECTION 1. INTRODUCTION TO MACHINERY HIRE SERVICES AS A BUSINESS

This section introduces and provides 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 agriculture for sustainable crop intensification and to the business in which small-holder farmer access required farm machinery on fee bases.

Learning objectives

At the end of this section trainees will be able to:

1. Define and describe what a hire service business is.
2. Define and describe the characteristics of a service and service types.
3. Understand the advantages and benefits of mechanization for smallholders.
4. Understand the importance of mechanization in the agri-production chain.

Duration: 6 hour

Training method

- Lecture and Discussion (group discussion, plenary presentation)
- Brainstorming
- Practical demonstration and exercises
- Case studies
- Role-Play

Learning question

1. What is hiring service business?
2. What are the different approaches to start hiring business?
3. What machineries are most likely used for hiring business and why?

1.1 WHAT IS MECHANIZATION HIRING SERVICE BUSINESS?

Agricultural Mechanization refers to the use of any kind of mechanical aids powered by humans, animals or engine/ motor for agricultural production. In its major functions, agricultural mechanization involves the use of powered machinery and tools that assist or substitute human labor and improve production efficiency. Mechanization can increase productivity, reduce the cost of production, optimizes product quality, provides timely inputs, and improves farmers' livelihoods.

Most farmers understand the benefits of using mechanization and usually demand machinery. However, not all farmers can afford to purchase high-end agricultural machines and equipment. Given small land sizes in Ethiopia Small-holder farms, even those who can afford to purchase might not utilize machinery efficiently if they use it only on their land. Hence, establishing a hire service for such agricultural machinery could be an alternative and beneficial practice enhancing farm mechanization.

Mechanization hire services primarily focus on providing machinery-based support for activities such as production, harvesting, threshing, shelling, transport, and certain post-harvest operations. At the post-harvest stage, these services may include drying, winnowing, cleaning, grading, and storage. At processing level hire services can contribute to chopping, milling, grinding and pressing. Hire services can also support packaging and transport and retailing of agricultural produce. There is potential to provide other services as well, such as for animal traction, water pumping and irrigation services, agro-processing. Hire services have also been found in infrastructure building and maintenance. For example, road building and maintenance as well as collection of

solid waste has been part of hiring services using farm machineries.

Most consumers of hire services are typically smallholder farmers within village communities who cultivate less than one hectare of land. In this context, hire services providers can be farmers themselves who have invested in draught animals and/or tractors and equipment, for their own use and have identified a potential for hiring services to their local markets. In more sophisticated settings, with more effective demands and better rewards, specialized service providers are commonly found. Hence,

- A hire service offers services, ranging from land clearing and soil tillage to processing and transport for marketing operations. It uses physical objects, such as tractors, combine harvesters and associated equipment, to provide services.
- The custom hiring service provider will give farm machinery on rental basis to farmers who cannot afford to purchase high-end agricultural machinery and equipment.
- A service involves the provision of work activities that offer benefits without transfer of ownership. A service is usually rented (based on time spent, work performed, area covered, etc.)

If anyone decides to run a hire service as a business enterprise, he should be prepared to:

1. Provide services on fee-bases.
2. Conduct business for profit.
3. Develop good relations with customers and clients, forging business partnerships.
4. Act as a businessperson (businessman/ businesswoman)
5. Organize the business.
6. Manage the business (management)
7. find ways to make money (business model).
8. Offer services (planting, spraying, transport, shelling etc.)
9. Have customers (farmers, people needing transport etc.)

1.2 BENEFITS OF MACHINERY HIRING AS A BUSINESS AND LIVELIHOOD ACTIVITY

At the household level, hire services are provided for several benefits, which include:

- Hire services at the household level will generally reduce drudgery, increase income and improve food security.
- With increased yields and increased time savings, farming becomes more efficient, and costs can be reduced.
- Create a favorable environment for other services to develop. Services such as machinery repair and maintenance will flourish as an enterprise.
- Technical linkages will be created, and knowledge improved in various aspects of mechanization.
- Gender issues- Typically women carry most of the burden of household work, farm work and taking goods to the market. A small-scale hire service can alleviate drudgery for women.
- Financial rewards- A hire service that generates profits will necessarily contribute to the farm business. It has the potential to increase income, reduce cash flow deficiency during the year and help with paying for extra expenses.

1.3 DIFFERENT APPROACHES FOR ESTABLISHING MACHINERY HIRING BUSINESSES.

- Cooperative-based – The organization is a conventional farmers' cooperative, or group previously established around banking or providing commodity inputs or collective marketing to its members. The organization decides to start its own hiring business of agro-machinery, usually offered at a below-market price to members and, if time permits, at market price for non-members.
- Group based machinery hiring- In some ways governments and development programs aid and support the formation of new groups (youth groups, women groups, etc,) or cooperatives around mechanization services.
- NGO-based Mechanization service – Generally, established rural NGOs advocate and play a critical role in developing and improving rural agrarian communities. Evidence from some countries indicates that the NGO sector hire services are some of the most successful in terms of area and numbers of farmers served with fair-priced services. This has not been very common in Ethiopia.
- Private sector-based hire service– This is likely the oldest existing form of Hire service provision. An individual or group of partners start a provision of agro-machinery services for profit and is marked by owning and providing a larger array of equipment

and services. It can broadly be classified into two categories: informal and formal. Informal are unregistered, mostly individual households owning machinery and providing services. The formal is relatively new and are organized and registered as a formal business.

1.4 MACHINERY TYPES COMMONLY USED FOR HIRING SERVICE PROVISION

Most new machinery buyers purchase either a tractor, power tiller, or mini tiller as their first machine, only after which attachments can be bought for tillage (plow), harvesting (reaper), and threshing (thresher). There are a few common types of machinery like pump sets, rice mills, and self-propelled reapers, which do not need any of the three above types of machinery.

Mini-tillers and electric pump sets are machines that do not earn a significant amount of money but are essential for commercial farming and could be a very good start in service provision enterprise. Those priority machinery have been grouped into five key combinations, based on engine and its attachment. These combinations are essential to make the business more feasible and viable.

Table 1. Priority machinery list with high service provision potentials for Rice-wheat and Rice-Maize cropping systems.

SN	RICE-WHEAT CROPPING SYSTEM	RICE-MAIZE CROPPING SYSTEM
1	Power Tiller	Power Tiller
2	Minitiller	Minitiller
3	Tractor	Tractor
4	Diesel Engine Pumpset	Diesel Engine Pumpset
5	Self-Propelled Reaper	Self-Propelled Reaper
6	Trailer	Trailer
7	2WT operated Reaper	2WT operated Reaper
8	Rice Mill	Rice Mill
9	Rice Thresher	Rice Thresher
10	Wheat Thresher	Maize Sheller
11	Harrow	Maize Planter

1. Two Wheel Tractor (Power Tiller)

- Reaper
- Trailer

2. Four Wheel Tractor

- Rotavator
- Disc Harrow
- Rice Thresher
- Wheat Thresher
- Trailer
- Maize Sheller
- Maize Planter

3. Self-Propelled Reaper

4. Mini Tiller

5. Combine Mill

Source FAO and CIMMYT, 2018.

1.4.1 IRRIGATION PUMPS

Increasing impact of climate change has led farmers to experience rain shortages and higher variability in rainfall. Faced with this challenge, farmers are turning to irrigation to enhance crop productivity. Hence, water pumps are becoming essential in agricultural production. However, as with other machines, not all farmers can afford to have their own water pumps; they therefore rely on hire services. Note that pumps can be self-propelled or driven by 2WT or small 4W Tractor engines. This is one approach to extend the annual use hour of the machine which could shorten the payback period for the loan taken for the purchase of the equipment. Different approaches would be possible to give pumping services, charging rate, payment modalities, etc.

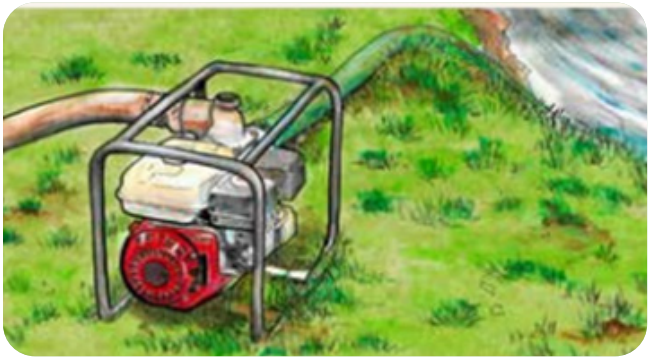


Figure 1. Engine-powered water pump can be suitable technology to run hire business.

1.4.3 HARVEST AND POST-HARVEST SERVICES

Harvest and post-harvest services include services in harvesting, combine harvesting, threshing, shelling, and processing of cereals, pulses, fruits, vegetables, and oilseeds. Custom hire of combines for harvesting is becoming more common in some parts of Ethiopia. with the increasing commercialization of smallholder agriculture associated with the adoption of sustainable intensification practices, it is a market niche that is likely to be more widely exploited. walk behind type harvesters are other sources of income which are becoming popular.

Threshing of cereal crops and shelling of grains, such as maize, are important post-harvest handling activities and are an attractive prospect for the service provider. Shelling and threshing hire services are also a good option for smallholder farmers, as the equipment can be expensive but not sufficiently used on a single farm. Mobile, engine-powered machines are popular and there are a wide range available on the market (locally manufactured, or made in India, China, and other countries)

Figure 3.Commonly used portable sheller and thresher.

1.4.4 GRAIN DEHULLER

Grain dehullers mechanically remove/peel the bran from the grain while also polishing the grain. This machine has had an important impact on small- and medium-scale operations, successfully replacing the arduous manual dehulling operations with a pestle and mortar carried out mainly by women. In general, the grain dehuller is installed alongside the hammer mill: it performs a first stage milling operation before the grains are ground into flour. Many engineering workshops in Africa fabricate grain dehullers.

1.4.5 TRACTOR DRAWN IMPLEMENTS

Table 3.4a Indicative overview of tractor and equipment for service provision

OPERATION	EQUIPMENTS	COMMENTS
Power Source	Tractor (45-100 hp) — 2 or 4-wteel drive	
Crop and material transport	Trailer (3-5 tones)	For year-round work.
Ploughing and subsoiling	Disc Subsoiler Mouldboard or chisel plough	Choice of plough depends on method generally practiced in the area. If agriculture (CA) is promoted, plough use will be phased out.
Harrowing	Offset disc for heavy operation	Choice depends on sod type. See comments on CA above.
Harrowing	Tandem disc harrow for lighter work	
Harrowing	Power harrow — PTO-driven	Priority in paddy rice areas and horticulture. lower priority in rainfed conditions.
Cultivating	Tined harrow	In some regions With light conditions, this is used for all cultivation.
Cultivating/weeding	Inter-row cultivator	Rather specialized — mostly used on large farms.

OPERATION	EQUIPMENTS	COMMENTS
Ripping	3-poett mounted ripper	Often favored by farmers wishing to eliminate ploughing and moving towards reduced tillage.
Sowing (drilling)- small grains	Seed drill	For cereal (e.g. wheat) areas. Direct drill for no-til farming.
Planting- maize, beans	Row planter	For maize areas. Direct planter for no-till.
Fertilizing	Tractor-mounted or trailed spreader	Mostly for large farms and fields.
Spraying	Tractor-mounted sprayer	Mostly for large farms and fields.
Grass and hay cutting	Rotary mower, cutter bar mower. rotary slasher, hay baler	For dairy and beef farms with predominance of grass and forage crops.
Forge harvesting	Self-propelled forage harvester	Expensive, Specialized machete for use on large farms and in large fields. Requires supporting tractors and trailers for transport to storage area. This is often a “stand alone” contracting operation.
Milling Pumping	PTO-driven hammer mill. PTO-powered water pump	Very good revenue earning operation for out-of-season work.
Harvesting- small grains	Reaper fitted to 2WT. Self-propelled forage harvester	Expensive, specialized machine for use on medium to large farms and in fields. Requires supporting and tractors and trailers for transport to storage area. Selection criteria include width Of the table — i.e. ability to travel along the roads in the area and access to fields.
Harvesting- maize	Self-propelled combine harvester with maize header	

Source FAO and CIMMYT, 2018

Exercises - Enlist the name of equipment/machines used for different field operations

1.5 MANAGING A HIRE SERVICE BUSINESS

Managing a hire service business involves overseeing its operations from a business-oriented perspective. Management entails making decisions on how to best utilize available resources, implementing those decisions, and ensuring that all activities and tasks are carried out effectively and efficiently.

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:

- Providing transport services that deliver farm produce to the correct destination as requested by the customer (doing the right things); or
- Conducting the transport service on time, at a reasonable cost and for a fair price (doing things right).

To achieve effectiveness and efficiency, the service must be planned, organized, coordinated and controlled properly, i.e., managed as a business. The hire service manager performs these functions in each of the key areas of the business: organizing equipment, dealing with customers, directing marketing and promotion, supervising operations, managing finances and managing risks. Risk management is critical because business involves great risk.

Skills required to manage a hire service are planning, organizing, coordinating, leading, implementing and controlling. The duties and responsibilities of the owner/manager typically comprise the following:

- Plan business resources and activities and ensure that the hire service operates in an environmentally friendly way.
- Organize the work.
- Lead and communicate with those who work in the business.
- Control resources – materials, machines, buildings, finances etc.
- Promote business with potential customers.
- Seek investment in the business.
- Communicate and work with others outside the

business.
- Look after customers.
- Gather information on matters that can affect the business.

1.5.1 DUTIES AND RESPONSIBILITIES OF THE OWNER/MANAGER

A manager wears many hats. Not only is a manager a team leader, but he or she is also a planner, organizer, leader, coach, problem solver, and decision maker — all rolled into one. And these are just a few of a manger's roles. In addition, managers' schedules are usually jam-packed. Whether they're busy with employee meetings, unexpected problems, or strategy sessions, managers often find little spare time on their calendars.

Three categories of the skills of a manager:

1. Interpersonal: This role involves human interaction.
2. Informational: This role involves the sharing and analyzing of information.
3. Decisional: This role involves decision making

Indeed, the main skills required to manage a hire service are planning, organizing, coordinating/ staffing, leading, implementing and controlling.

A good manager discovers how to master these five basic functions: planning, organizing, staffing, leading, and controlling.

1. **Planning:** Is the process of establishing objectives and selecting future courses of actions for their accomplishment. Deciding in advance what to do, how to do, when to do and who is to do. If you fail to plan you are planning to fail.
2. **Organizing:** After a plan is in place, a manager needs to organize his team and materials according to the plan. Assigning work and granting authority are two important elements of organizing.
3. **Staffing:** After a manager discerns his area's needs, he may decide to beef up his staffing by recruiting, selecting, training, and developing employees. A manager in a large organization often works with the company's human resources department to accomplish this goal.
4. **Leading:** A manager needs to do more than just plan, organize, and staff his/her team to achieve a goal. He/She must also lead. Leading involves motivating, communicating, guiding, and encouraging. It requires the manager to coach, assist, and problem solve with employees.
5. **Controlling:** After the other elements are in place, a manager's job is not finished. He needs to continuously check results against goals and take any corrective actions necessary to make sure that his area's plans remain on track.

Successful management of the farm requires having the following qualities:

- The ability to organize and achieve specific goals and targets set by the organization,
- A good understanding of technical issues involved in the production and marketing of farm products,
- The ability to communicate with people to obtain good information.

1.5.2 MANAGING BUSINESSES

Hire service entrepreneurs understand the need to develop their business management skills.

Diagnosis: Managers of hire services require analytical skills to understand the business in all its parts. They must identify the constraints and opportunities that affect profitability. This entails analyzing the cause of problems and identifying ways to overcome them.

Planning: Entrepreneurial managers are effective planners. Planning is fundamental for running a profitable business. Plans are based on the resources available, and the business objectives set. The planning process involves choosing a particular course of action from various alternatives with the aim of attaining these objectives.

Organization: Managers prepare to implement a plan; they get everything in order, obtaining the inputs, materials and money needed to put a plan into effect. Successful managers are good implementers: determined and methodical in executing their plans.

Leadership: The successful manager is a good leader,

motivating, enabling and drawing out the talent of staff to achieve the goals of the business. Motivation requires good communication, building trust and confidence, creating a climate that encourages good performance and developing the capabilities, skills and competencies of staff.

Control: A successful businessperson understands the importance of controlling the business and making sure that performance goes according to plan and expectations. Sometimes called "monitoring", control implies checking the progress of the business – in part or whole over time. Control is more than observation: a manager must carry out regular checks as plans are implemented, even when implemented successfully. Control requires daily monitoring, comparing expectations with actual performance and results, to identify weak points and adjust aspects of the business to improve performance.

1.5.3 MANAGING BUSINESS RISKS

Hire service providers are exposed to uncertainties of weather, prices and policies. Uncertainty impacts the business both directly and indirectly (through its customers):

- Variations in rainfall condition affects the timing of machinery operations in land preparation and tillage.
- Attacks by pests and or infection by diseases affect the need for hire services.
- Price variations affect the income of farmers, influencing the demand for custom hire services.

The risks faced by farmers affect the risks of the hire business. Business risks for hire service suppliers lead to uncertain profits and the danger of losses occurring. Although many risks are not actually under the control of the hire service providers themselves, management strategies can still help cope with them. Moreover, a hire service business often faces interrelated risks:

- The ability to repay debts depends on the volume of services contracted and the custom hiring charges set.
- Financing the business depends on the ability to borrow money and the capacity of the lender to supply credit in time.

Different types of risk often need to be considered together and a good manager balances risks: an action that increases risk in one part of the business can be weighed against actions taken to reduce risk. Given the many sources of risk, management strategies must integrate different responses. This is called risk management.

1.5.4 MANAGING FARM MACHINERY

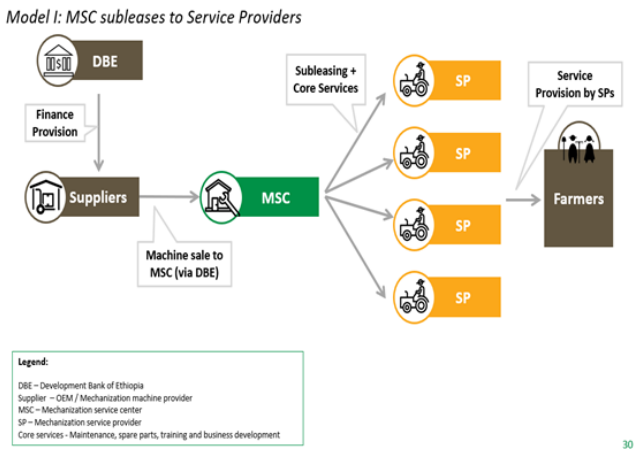
Machinery management includes:

- Selecting the best size and type of equipment for each application
- Determining the cost for performing a particular operation
- Matching machinery components in a complete system
- Establishing a complete maintenance program
- Determining the optimum age for replacing a particular machine
- Scheduling farm operations for the best use of the machine and other factors (Section 3).

1.6 HIRE SERVICE BUSINESS ORGANIZATION

The hire service business can be divided into key parts.

- Organization of the business.
- Management and leadership.
- Hire services offered; and
- Relationships developed with suppliers, farmer customers and financial organizations.



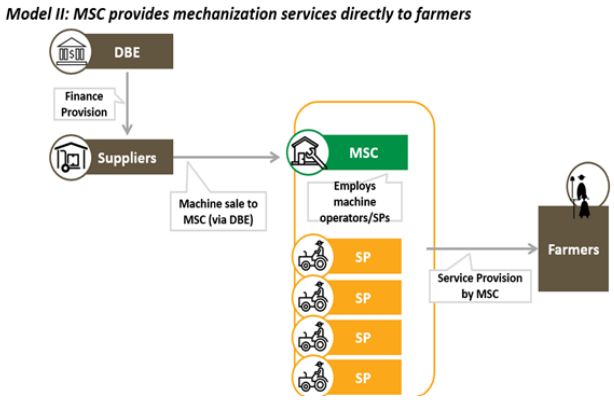


Figure 4. Organization (service model) two possible service provision approaches suggested for MSC application. (SP = service provider)

The organization of the business entails a wide range of issues:

Ownership: There are various forms of ownership:

- **Sole proprietor:** A single person- a farmer, dealer or other entrepreneur- owns the hire service.
- **Partnership:** Two or more farmers own the business; partnerships can be permanent or temporary.
- **Group:** A group may be a formal organization (e.g., cooperative or farmer association) or an informal association (e.g., self-help group).

There are advantages and disadvantages to each form of ownership and careful consideration is required when deciding the best form of business organization. For example, a partnership between two farmers has the advantage of reduced costs when buying a tractor and equipment; on the other hand, the farmers have their own requirements regarding personal use and, consequently, limitations about availability for hire services.

Legal status: Registration of a hire service may be mandatory, and a license needed to operate the business. Tax payments, social security contributions for employees and insurance to cover against accidents at work may also be required.

Assets: Business assets include premises, stores, office, machinery, and spare parts. Even a small hire service has business premises, for example, a stable to keep draught animals and a shed to keep equipment and tools. A hire service managed by a machinery dealer may have a wide range of assets, including tractors, equipment, a storage room with spare parts, an office, a repair workshop with tools and a garage for the tractors. The manager must identify, record and know the value of the business assets to make effective decisions.

Staff: Most small-scale hire services only hire casual workers on an occasional basis. However, when a small business is successful, it grows and eventually needs hired labor. As it expands further, it may also need to employ administrative and financial staff. With growing staff numbers, human resource planning can help understand how many and what kind of staff are needed to run the hire service business. Depending on the range of services offered by the business and following an assessment of customer demand, it is possible to gain an indication of the number of machines needed and of the staff required to operate them. Choosing the most appropriate staff for carrying out the functions of the business is an important aspect of managing the hire service as a business. Once the number of employees required has been estimated, the manager should set about the systematic recruiting, training and managing of staff, developing policies and employment conditions that attract, motivate and keep skilled and competent staff.

Supplier relations and linkages: Hire service providers often must collaborate and coordinate activities with other supply chain stakeholders. These may include importers, dealers, manufacturers and repair workshops. The smooth delivery of machines, accessories and spare parts to the business helps maintain customer satisfaction. The swift delivery of spare parts ensures timely service to customers and more affordable hire charges. The manager must nurture relations with stakeholders in the supply chain: strengthening relationships can lead to long-term commitments in supplies and reduced variability, with a potential increase in profitability.

Customer relations: Customers are essential to the success of the hire service business. Without customers, there is no income, and the business fails. Hire service customers can be categorized by farm size (smallholder farmers or larger farmers) or according to their demand for services. Hire service businesses need to be able to target different customer types, such as

- Small farmers in maize- or rice-based rainfed farming systems
- Medium-scale farmers involved in irrigated farming; and
- Households not actually involved in farming but who wish to use hire services for the transport of produce or people.

Post assessment questions

1. Discuss the different approaches for establishing a hiring business in mechanization.
2. What are the characteristics of Machinery hiring service business?
3. What are the main duties and responsibilities of hiring service managers?
4. What are the main skills required for managing Machinery Hire service business?
5. Discuss available legal frameworks governing Mechanization service provision.

Take away message

Hiring business give opportunity for SHF to benefit from mechanization while creating decent income for local businessmen. This business can be started using different machineries.

SECTION 2. UNDERSTANDING LOCAL AREA AND MARKET FOR MACHINERY HIRE SERVICE.

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 presence and 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 neighborhood is also required for the business to operate effectively and efficiently. It is thus very important to assess the local situations affecting the success of the enterprise to be established.

This module provides an overview of the importance of a local area and market assessment. It 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.

Learning objectives

This section enables trainees to

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

Training Duration - It requires 6 hours to complete this section.

Training method

- Lecture and group discussions
- Field visit
- Presentation of findings
- Brainstorming
- Stakeholder interviews

Learning question

1. What are the basic procedures followed to conduct a market and support service assessment?
2. How important is it to formulate good questions during an assessment?
3. Why and how to Identify financial organizations that can provide credit in the vicinity?
4. What support services are important for mechanization hiring business?

Hire service enterprises of whatever type and offering whatever services (rental, lease, and custom services) are challenging business. Challenges and constraints derive from a multitude of factors:

- A lack of money to finance investments.
- Difficult access to loans and the correlated risks involved in interest rates and repayment schedules.
- Lack of access to information regarding the most appropriate type of equipment for farming systems.
- The need for a well-functioning input supply chain and for other necessary support services to be in place.

Further, some farming systems are not intensive so that markets for hire service enterprises may be limited. Moreover, due to the seasonality of agriculture, the demand for hire services is time bound and synchronic (demand arises at the same time). Finding enough clients to hire services all year round can also be challenging. These challenges should be considered by conducting a feasibility study for a hire service enterprise prior to investing money, time, effort and energy.

A feasibility study can help service providers in estimating the level of business challenges found in a local area and eventually taking the decision to start or not a hire service enterprise. It will provide would-be service entrepreneurs with estimates of

- What types of hire services may be required in a local area (for example, simple renting, a custom hire that involves a specific amount of work to be done, leasing, etc.)
- Whether such service is profitable enough to justify investments in things as tools, and machinery.
- What level of investment is required for the business and the feasibility for the machine services to begin.
- How much money will be required for investment to start up the business.
- Credit availability in the area
- Costs and profit margins to be expected.
- If there is a functioning input supply chain in the area that can provide spare parts, veterinary services, and so forth.

Some questions for consideration for a feasibility study

- Who are potential customers and how many are there in the local area?
- What are the main farming constraints that are faced, and would it be possible to solve them by hiring the appropriate service?
- Can the service be effectively and efficiently supplied by small-scale farmer entrepreneurs?
- What are the available time windows for such work in the local area?
- Can complementary services be offered to create a hire service job market more uniformly throughout the year?
- Are there any competitors offering a similar service?
- How much do they charge?
- What would the enterprise cost? Can it compete?
- What are the strengths and weaknesses of the enterprise compared with the competition?

2.2 HOW TO CONDUCT 'LOCAL AREA ASSESSMENT

An assessment of the local area includes a market and support service appraisal. Each step in the assessment process relates to a specific activity to be conducted:

1. Identify clear and concise objectives for the assessment.

2. Determine what information is needed.

3. Establish where the information can be found.

4. Devise a plan for information collection.

5. Decide how to record this information.

6. Analyses the information to enable better decision-making in the business

There are two options to conduct this assessment.

Option 1: A field visit exercise and is subject to local circumstances, time availability and budget; you are the best judge to decide if a field visit is possible.

Option 2: Available if a field visit is not possible: stakeholders – key local people (e.g., farmers, traders, equipment dealers, blacksmiths, mechanics, bankers and NGOs) – can be invited to the training session to make presentations and be interviewed by the participants. Interviews follow the same steps in both field visits and stakeholder visits.

2.2.1 WHAT AND WHOM TO ASSESS?

An assessment process involves investigating agricultural situations, markets, and support services to:

1. Discover potential business opportunities for the hire service providers.
2. Understand available market and
3. Identify the support services needed to operate as a business.

A simple assessment involves observation of local farms (soil types/conditions, what is grown/reared, farm size etc.) and informal talks with farmers to find out what services may be needed and what prices they are willing to pay. A more elaborate assessment may require visits to farms; observation of farm sizes, cropping patterns etc.; questions to farmers about what mechanization services they need, when they need them and what prices they are willing to pay; and research into eventual competition, the services offered and at what prices are paid for which service. Consulting experts from extension service (BoA) will be essential.

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 effectively. Support services include:

MECHANIZATION SUPPORT SERVICES						
Equipment dealership	Spare parts dealer.	Maintenance and repair service.	Fuel Supply	Training institutions.	Credit organizations	Roads, telecommunication and other services (mobile phone)

Dealers provide machinery, equipment, and spare parts, as well as advice on operational and technical aspects; they may also provide training. Service providers offering maintenance and repair services, such as local blacksmiths or mechanics, may be fundamental for keeping a hire service in business.

The minimum support services required are a fuel supplier, a spare parts dealer, and a mechanic for tractor powered equipment.

Support services must be reliable. For example, it is vital that fuel is of good quality and available regularly; spare parts are not too expensive and are of good

quality and readily available; and repair services effectively restore machinery to working condition. The information can be used in various ways:

1. Identify potential customers (farmers, traders, processors etc.)
2. Understand local farming systems (farm sizes, cropping patterns etc.)
3. Understand the nature and fragility of local natural resources (soil types, water resources, forests etc.)
4. Understand customer needs and what they require (no-till seeding, water pumping, transport etc.)
5. Determine what prices to charge for services.
6. Understand the location and capacity of support service providers in the local area.
7. Facilitate decision-making regarding offering new services.

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

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

2.2.2 ASSESSMENT OF LOCAL AGRICULTURAL PRACTICES

The selection process begins with a detailed assessment of farms, markets, competition and support services, providing a foundation on which to plan for the selection of appropriate mechanization equipment. Particular attention is paid to the following factors:

Local cropping patterns (both existing and potential): an important indication of the types of tractors, machines (including those used for post-harvest handling), draught animals and implements required. Information is required about the cropping patterns practiced on the individual crops grown within that pattern (see Module 2). For example, whether the main crop is a small grain crop or maize conditions the choice between a seed drill and a row crop planter for planting, or between a cutter-bar table and a maize header for combine harvesting. Similarly, annual crops (e.g., cereals and legumes) generally have different requirements for mechanization compared with perennial crops (e.g., coffee and sugar cane).

Profitability of crops grown by potential clients: a customer's aspirations do not always match what they are prepared to pay for. Farmers are not necessarily able to fully mechanize all their crop production; a prospective hire service business should discuss with farmers, and use other knowledge sources, to identify farmers' priorities.

Priorities: of other customers in the agri-food value chain (see Module 1), considering, for example, the need for transport services by local traders and processors, or the need for processing operations (shelling, threshing and milling).

Non-agricultural opportunities: such as rural transport, road building and maintenance for local authorities, stationary work (e.g., water pumping) and forestry work

Prices that farmers and other agri-food value chain actors are willing to pay for services, to make basic comparison between the costs of providing a service and money received for the service provided. This gives an indication of the potential profit from each service and of what machinery can be justified. Profit calculations give an overall estimation of the money the hire service business needs both to start up and to operate.

Competition: what services competitors are providing and for whom, when, how often, and importantly what prices are charged. An assessment of the competition can indicate new types of services that can be provided in the area. Rates must be competitive.

Support services: available in the local area, for example, financial services, fuel suppliers, spare parts dealers, mechanics and veterinarians, all of which are important for the successful functioning of agricultural machinery.

Once the above factors have been thoroughly assessed, it is important to examine the technical

criteria, such as:

- Size and power of tractor and power sources.
- Equipment specifications for the required tasks.

The main investment for a hire service business is tractors, to which a great variety of implements can be attached. Once a tractor or other power source has been purchased, there are a vast range of implements and post-harvest handling machines available for potential investment, and the risk of selecting the wrong implement is great. In many situations, the priority is land preparation implements (e.g., ploughs and harrows.

The technical considerations need to be aligned with financial considerations. For example, the money the hire service business has at its disposal (cash flow) gives an idea of the money that can be invested in the equipment (investment appraisal), and if the hire service business does not have the necessary money, it is necessary to examine the potential to get it on credit (loan appraisal).

2.2.3 STEPS FOR CONDUCTING MARKET ASSESSMENT

The market assessment process is composed of the following 5 steps.

Step 1. Decide what market information is needed.
Step 2. Consider where the market information can be found.
Step 3. Make a plan to collect the market information.
Step 4. Devise a method for recording the market information
Step 5. Analyze the market information collected.

Step 1. Decide What Market Information Is Needed

What. Identifying the specific types of services required is essential. Types of services potentially required include sowing crops, water pumping, harvesting, processing and transport.

Who. Knowing who customers are is a fundamental aspect of a hire service business. A hire business needs to identify its potential consumers, for example, farmers, traders, processors, local construction companies, local municipalities and people needing transport.

Why. Understanding customers' needs – why they require hire services – is crucial. Potential customers will buy services to fulfil their specific needs. For example, a trader may need transport services to collect produce from various farms and then take it to a processor and/or market; a farmer may need crop planting services.

When. Understanding not only what services to provide, but when to provide them (timing), is critical, as demands for services may occur at the same time of the year.

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. For example, a quality harvest service is provided on time, is carried out properly with minimum crop damage, has low in-field crop losses and is competitively priced.

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.

What, Who, why, when, what kind and how much are the most important questions for a hire service provider. However, other market information is also important and may include, for example, what other new services can be provided or where the most profitable services can be sold. Experience and willingness to form Farmers' production Clusters for economic use, benefits and limitations that may discouraged farmers in the service delivery (quality, timeliness, price) and future potential services that could be incorporated need to be investigated.

Once the information needed is Identified, then establish clear and concise information-gathering objectives as a guide to the market assessment process, for example:

- Who are the potential customers and who will become the actual customers?

- What are the average farm sizes and what are the predominant cropping systems?
- What specific services are required?
- Where are these services required?
- When are these services required?
- How much will real customers pay for these services?
- How severe is the competition?
- How many other businesses provide similar services?
- What quality of service do competitors offer?

Step 2. Consider Where the Market Information Can Be Found

Once the information objectives are established, identify where information can be found. For example, to understand customer needs, ask questions directly to potential consumers, farmers and traders. To discover what transport opportunities there are, visual observation of a market entrance may be a good source of information. 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. Plan to Collect the Market Information

Gather information methodically, following a plan. For example, a potential plan for collecting information from fuel, spare part and repair service providers, entails the following:

- Decide which providers will 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.
- Calculate the costs entailed.

Step 4. Devise A Method for Recording the Market Information

Recording the information is essential. Simply remembering information is not sufficient: it is difficult and not reliable. Write down all interview responses and visual observations.

Step 5. Analyze The Information Collected

Once collected and recorded, the information needs to be read, understood and carefully analyzed. Interviews with traders and farmers etc. produce a lot of information. For example: traders need transport services once a week throughout the harvest season, but they are only willing to pay low prices; on the other hand, farmers may need harvesting and threshing services during the harvest season and offer good prices for such services. The provider needs to analyze the service options and identify the most profitable services in each season.

The analysis produces a lot of information: what services are required and when; the prices that can be charged. This information is essential for making business decisions. The more assessments are carried out, and the more specific they are, the better hire service providers become at carrying out assessments and the more information they gather. The provider becomes increasingly knowledgeable and capable of creating opportunities to develop the hire service business.

2.2.4 ASSESSMENT OF FINANCIAL SOURCES

The credit and credit organization assessment process in summary:

Step 1: Decide what information is needed to assess finance and credit organizations.
Step 2: Consider where the information can be found.
Step 3: Plan for collecting the information.
Step 4: Devise a method for recording the information
Step 5: Analyze the information collected

Step 1. Decide What Information Is Needed to Assess Finance and Credit Organizations

A hire service provider requires the following information:

1. **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.

2. **Type of credit.** It is important to understand what types of credit are available in the local area. Credit in the medium term (1–3-year payback period) and long term (>3-year payback period) is often used to buy tractors and equipment. However, there may be other types of credit available in the local area, for example, leasing from a manufacturer or dealer. Credit with a <1year payback period can be useful for covering the running costs of the hire service, for example machinery maintenance and repair costs.
3. **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.
4. **Guarantees**. Credit usually requires the hire service business to provide a guarantee (assets or collateral). It is important to understand what guarantees are required to obtain credit. Guarantees are usually assets that can be easily converted into cash if they are sold. Typical guarantees for credit are land, a house, or the business premises of the hire service. It is increasingly common practice for the guarantee to be the tractor or equipment being purchased; if payments are not made to repay the loan, the tractor is withdrawn and sold to recoup the outstanding loan.
5. **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.

Once this information has been gathered, you can establish clear and concise objectives, which serve as a guide during the assessment process, for example:

1. Who are the potential lenders – individuals and organizations
2. who can be approached for a loan for buying a tractor in the local area?
3. What type of credit do they offer?
4. What are their terms and conditions?
5. What specific guarantees do such loans require?
6. What are the interest rates on the various types of loans?
7. Will the credit be delivered within the required time frame?
8. What happens if loan repayment installments are delayed or not paid?

Step 2. Consider Where the Information Can Be Found

Having established the objectives, identify where to find the information. For example, to learn about types of credit available in the local area, ask questions directly to potential lenders (e.g., machinery franchises).

Step 3. Plan for Collecting the Information

Information collection must follow a plan. For example, if information from banks is required, the plan could be as follows:

- Decide which banks and other financial organizations (formal and informal) 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.
- Calculate the cost.

Step 4. Devise A Method for Recording the Information

As mentioned in Step 3, it is important to record the information collected. Some hire service providers may be able to remember, but this is difficult and unreliable. Therefore, it is important to write down or record all interview responses and visual observations (using, for example, a mobile phone).

Step 5. Analyze the Information Collected

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

2.3 CONDUCTING A FIELD VISIT OR INTERVIEWING KEY STAKEHOLDERS

You are going on a field visit to practice carrying out an assessment. With the support and help of your trainer, you need to prepare thoroughly for the exercise. You need to think about your future hire service business and what equipment you need. For example, imagine that your business assets include a two-wheel tractor, a seeder and a transport trailer.

Before preparing the assessment process, you must specify what services you can offer with your hire service. The data collection and analysis process comprise the following steps:

Step 1. Decide what information is needed to appraise support services.

Step 2. Consider where the information can be found.

Step 3. Make a plan for collecting the information.

Step 4. Devise a method for recording the information.

Step 5. Analyze the information collected.

Once you have defined the services you can offer, it is important to prepare for Step 1 of the assessment process. Write down clearly the general information you need: clarify your business objectives, the machinery and equipment needed and the services that you offer or would like to offer.

For Step 2, you need to think about the specific data or information required to run the hire service business more effectively. Draw up a list of questions around the information needs directed to different actors in the machinery supply chain, including dealers, repair workshops, financial service providers (informal moneylenders and banks) and hire service customers. The checklist of questions should be clear and concise, for example:

For customers:

- Do you use tractor services?
- Do you use draught animal services?
- What tractor services do you use?
- What draught animal services do you use?
- When do you need these services?
- What prices do you pay for these services How is the payment settled?

For financial service providers:

- What type of credit services do you offer?
- How can this credit be used?
- What are the interest rates and payback periods on different types of loans?
- What guarantees do you require on a loan?
- How long does it take to make a loan available?

For dealers and repair workshop owners:

- What type of repair services do you offer?
- What spare parts do you have?
- How long does it take to order spare parts?
- What tractor and other agricultural machinery repairs are you able to undertake?
- What are most Frequently encountered problems and what methods used to overcoming these setbacks?
- What do you suggestions for improvement?

Use a checklist as you ask the questions, but do not be afraid to follow up with additional questions not on your list. Consider carefully how you will record the answers to your questions.

During the field visit, you will observe the local area and different businesses to gain a sense of their capacity, performance, and trustworthiness. Think about the people you will meet and what you will observe.

Step 3 and Step 4 involve preparing a plan for collecting and recording the information. Consider the following:

- Who are the people you will interview?
- Where can they be found and when?
- What questions will you ask them?
- How long will the interviews take?
- How will you record the interview information?
- What will you be observing?
- How will you record the information?

At this stage, you have made all the required preparations for the field visit. The trainer will advise on the detailed itinerary for the field visit. On return from the field visit, follow Step 5 of the assessment process: read over the information collected and analyze it. Finally, present your findings to other participants.

2.4 SERVICE MAP AND SERVICE DELIVERY PLAN

After carrying out the assessment, doing the analysis of the collected information, establishing the local context, 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.

Service Map

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 should be indicated.

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].

Figure 5. Service Sample Delivery Plan for a Hire Service Provider

OPERATION	RIPPING	PLANTING MAIZE	PUDDLING PADDY	WEEDING	HARVESTING PADDY	THRESHING PADDY	SHELLING MAIZE	TRANSPORT PRODUCE	TRANSPORT MATERIALS
Timing	4 weeks/ season	3 weeks/ season	4 weeks/ season	2 weeks 2/ season	2 weeks/ season	2 weeks/ season	2 weeks/ season	4 weeks/ season	One week/ month
Jan									
Feb									
Mar									
Apr									
May									
Jun									
Jul									
Aug									
Sep									
Oct									
Nov									
Dec									

Record Of Fuel, Oil, And Repairs

DATE	TYPE OF WORK	FUEL USED			OIL USED	HOURS	NOTES ON OTHER LUBRICATION COSTS, REPAIR, ETC.
		GAUGE AT START	GAUGE AT STOP	GALLONS USED	QUARTS		

Table 2. Record sheet for fuel oil and repair

Post assessment questions

1. What are the main purposes of conducting local area assessment?
2. What are the main support service providers to be included in the assessment and why?
3. Describe procedures to be followed to conduct market assessment?

Take away message

A simple assessment involves observation of local farms and find out what services are needed and what prices farmers are willing to pay.

SECTION 3. SELECTION AND MANAGEMENT OF FARM MACHINERY: TECHNICAL AND FINANCIAL ASPECTS

This section deals with the technical and financial aspects of machinery identification and management. The section imparts the skills required to understand the importance of selecting farm machinery for business. Through an analysis of some of the technical and financial aspects and related factors (e.g., costs, customers and priorities), it equips participants to make selections of appropriate and optimally sized power sources and implements, helping them to identify critical factors and understand power source and implement performance in the field. It covers the following issues:

- Local farming systems, markets, and support service considerations.
- Technical and financial selection considerations.
- Estimating machinery outputs.
- Impact of the working environment.
- Making investment decisions.

Learning objectives

1. Recognize the importance of different assessments in the selection of farm power and machinery.
2. Use the information on local situations for selection of farm machinery.
3. Understand the technical and financial criteria involved in the selection of farm machinery and equipment.

Training Duration: 18 hr

Training method

- Lecture and Discussion
- Brainstorming
- Practical demonstration
- Practical exercises
- Role-play

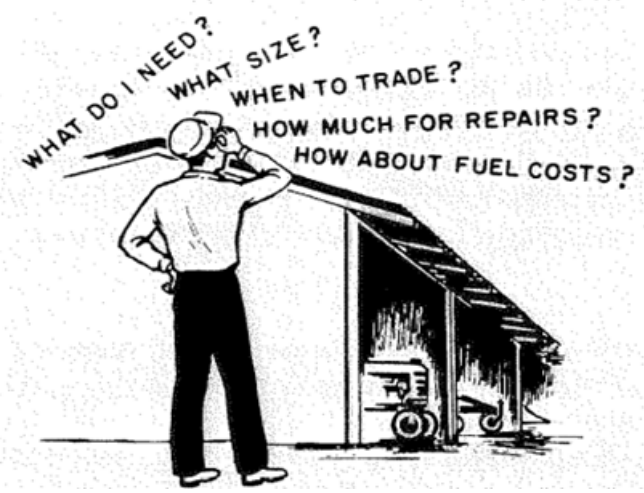
Learning questions

1. What is optimum size of machinery? How to determine the optimum size and number of machines for service provision in selected area?
2. What is machine performance and how to assess performance?
3. How to determine machinery cost and determine breakeven point for hiring business?

3.1 IMPORTANT POINTS FOR SELECTION OF FARM MACHINERY

After full understanding of the business environment in detail, the next issue mechanization services managers should know is to decide on the types and quantity of agricultural machinery needed for providing custom hire services to the farmers. This decision is to be made taking many factors into consideration, of which the following are key considerations.

- The physical characteristic of the area.
- The major type(s) of commodities grown by farmers that need mechanization services.
- The type and size of mechanization services needed by smallholder farmers in the area (demand side)
- The availability and type of agricultural mechanization technologies in the market (supply side)
- The profitability/sustainability of the mechanization service business



The type and size of tractor horsepower, as the most important part of farm machinery, on the other hand, will depend manly on the nature of the soil. Black clay soils, sandy soils, clay loam soils etc. will need a specific type and size of tractors. For instance, in areas where black clay cotton soils are the dominant, the tractor horsepower is expected to be higher, may need larger horse powers (>90 HP) as compared to areas where the dominant soil is sandy/sandy loam. In areas with light loam soils 2WTs could be applicable for ploughing, planting, and other services.

LIGHT SOILS	MEDIUM SOILS	HEAVY SOILS
Light soils contain a high proportion of sand. These soils are low in plant nutrients and drain quickly after rain or watering (poor water holding capacity). Nutrients are washed out quickly after fertilizing. Light soils are easy to cultivate and to mechanize.	Medium soils have a comparatively even distribution of sand, silt and clay. These soils are fertile, well-drained and easily worked. They have good moisture retention capacity. They are the best soils for crop production and mechanization.	These soils are potentially fertile as they are rich in nutrients, but difficult to manage. They drain slowly and can be waterlogged, Heavy soils can easily compact when wet and they bake hard in the dry season. They pose challenges for mechanization.
To determine the soil type, a handful of damp soil is picked up and squeezed tightly in the fist to form a ball. After opening the hand, the following result is observed:		
Light soils will not hold together and crumble easily. They feel coarse and gritty to the touch.	Medium soils will form a loose ball.	Heavy soils will form a hard ball. They feel soft and very sticky to the touch.

The size and distribution of the plots of smallholder farmers also will influence the type and nature of machinery to be applicable in that area. Despite the nature of the soil, it will be much easier for service providers to use smaller size tractors or 2WTs for serving smallholder farmers as to move machinery easily in less accessible rural areas. Hence, custom hire mechanization service provider managers must consider thoroughly the physical characteristic of their operation areas.

Equally important is the type(s) of dominant agricultural commodity(ies) grown in that area. Each agricultural commodity needs its own type of agricultural machinery for accomplishing varies agricultural activities (ploughing, planting, cultivation, harvesting, threshing/shelling etc). For instance, wheat and maize clusters need different machinery types for harvesting and planting, though the two crops might share the same machinery for land preparation and transportation services. Hence, an important analysis must be undertaken in the area to know the major commodities that need mechanization services in the MS operational area.

Other factor that managers shall consider is the emerging demand of the smallholder farmers in the operation area. It is quite important to know what mechanization services are currently needed, which services are to come next and which ones can be given priority. Information available in the agricultural extension system or any study conducted in agricultural machinery adoption and utilization status would be used for great advantage. A simple rapid assessment by the service provider can also give a clue to know the status of the current demand and prospects of agricultural mechanization service business in the area. This means managers can decide and invest more initially in the intervention that have demand and go on expanding on those activities where demand for mechanization services is not developed. This will also tell the managers that the level of investment to be done in promoting the various mechanization services in the area.

The supply side is also another area that influences the decision on the type of mechanization technologies available in the market. There should be a sustainable supply of appropriate and suitable technologies that meet the demand of smallholder farmers in each operation site. This means Mechanization services providers are required to be sure which agricultural machinery and implements are available in the market and which brands are satisfactory in terms of service quality and long-term utilization.

To fully understand the farm machinery requirement, i.e., the type, size, and number of machineries required one should make.

Farm Assessment: Assessing farm size, terrain, topography, and soil conditions to determine machinery needs.

Task Analysis: Identifying specific tasks and operations required throughout the farming cycle, from planting to harvesting.

Crop Analysis: Analyzing crop types, rotation patterns, and crop-specific machinery requirements.

Future Planning: Considering future expansion plans and changes in farming practices that may influence machinery needs.

3.2 FACTORS THAT AFFECT THE SIZE OF MACHINERY NEEDED

Selection of the correct implements for service provision depends on the demand from the customer and on what is customarily used in the agri-food value chain. It is therefore recommended to observe what other farmers are using as it is difficult for a hire service to persuade farmers to adopt methods which they are not familiar with. Farmers tend to be very conservative because the use of something new and untried technology could lead to decreased yields or even crop failure.

The selection of the tractors, as the most important component of farm machinery hire service business, involves making complex assessment and driving decisions on several technical issues such as:

- What are the most suitable sizes and types of tractors?
- How much work are they able to carry out?
- What are the risks involved?
- What are the requirements for drivers and support personnel?
- What operating costs are involved?
- What are the financial considerations?
- How many are required?

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, high timeline cost, 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.

Machinery recommendations must be based on the characteristics of each individual farm. The following factors influence machinery selection.

Farm Size: As more crop areas are farmed, larger-scale machinery is needed to ensure that planting and harvesting are completed in a timely fashion. The total acreage and layout of the farm will dictate the scale of machinery needed. Larger farms may require larger, more powerful equipment, while smaller operations may benefit from compact or multifunctional machines.

Crop Type: Different crops have specific requirements. For example, row crops like corn and soybeans may need planters and harvesters, while specialty crops might require specialized equipment.

Operational Needs: Assessing the specific tasks that need to be performed—such as planting, harvesting, tilling, or irrigation—will help determine the necessary machinery.

Budget: The financial capacity to purchase new vs. used equipment, as well as ongoing maintenance and operational costs, is crucial in decision-making.

Labor Availability: The availability and skill level of labor can influence machinery choice. Automated or advanced machinery may reduce the need for manual labor. The number of hectares that can be completed

each day is the most critical measure of machinery capacity. Increasing the labor supply by hiring extra operators or by working longer hours during critical periods may be a relatively inexpensive way of stretching machinery capacity.

Technology Integration: Consideration of precision agriculture technologies and how they can be integrated into existing operations can guide machinery selection.

Maintenance and Repair Costs: Understanding the long-term maintenance needs and repair costs associated with different types of machinery is important for budgeting.

Regulatory Compliance: Local regulations regarding emissions, noise, and safety standards can affect the type of machinery that can be legally operated.

Future Growth Plans: Anticipating future expansion or diversification of farming operations can impact the choice of machinery, favoring equipment that allows for scalability.

Tillage Practices: The number of field days needed before planting is completed depends partly on the number of separate operations completed on each hectare. Reducing the number of tillage practices performed or performing more than one practice in the same trip effectively decreases the amount of machinery capacity needed to complete field operations on time.

Crop Mix: Diversification of crops tends to spread out the periods when timely completion of field operations is critical. For example, yield reductions due to late planting begin later for soybeans than for corn. Harvesting can also be completed over a longer period. Thus, growing more than one or two crops reduces the machinery capacity needed for a given number of crop acres. However, it may also require purchasing additional types of machinery, especially for harvesting.

Weather: Weather patterns determine the number of days suitable for fieldwork in a given time each year. Machinery selection should be based on long-run weather patterns even though it results in excess machinery capacity in some years and insufficient capacity in other years.

Risk Management: Fluctuations in the number and occurrence of suitable field days from year-to-year cause timeliness costs to vary even when the machinery set, number of crop acres and labor supply do not change. Investing in larger machinery can reduce the variability of net machinery costs by ensuring that crops are planted and harvested on time even in years in which there are few good working days. Machinery fixed costs would be higher with larger machinery, but they would not fluctuate if the machinery set did not change.

The best size and number of machines: there must be enough use of the machine to justify it economically and keep the cost per unit of use at a reasonable level.

Peak demands usually determine the best size of tractor for use in such operation as plowing and discing. Tractors should be large enough to complete ploughing and other seedbed preparations on time. The number of tractors should be determined by the total work to be done and the number of workers on the farm. You need as many tractors as you have operators during peak periods. You can economically justify an extra tractor only it saves more in labor, convenance and operating cost each year than the amount of its annual fixed cost.

3.3 TECHNICAL ASPECTS FOR MACHINERY SELECTION

Machinery Selection: is determining the proper size and type of machine for a given type and size of farm. One of the most difficult problems in farm machinery hiring service business is proper machinery selection.

Selection process of machinery often complicated by a wide range of types and sizes available. It is also closely related to and dependent upon capital availability, labor requirements and availability, crop and livestock enterprises in the farm plan and other factors.

The decision includes judgment of the material efficiency of the machine, availability of dealer service, and the economic worth of the machine to the farm enterprise. In some instances, the decision is one of whether to mechanize.

Questions to be asked in machinery selection decisions may include.

1. Will the machine perform the desired job satisfactorily and increase farm profit?
2. Does the machine have enough capacity to complete the job on time with little loss from timeliness?
3. Is the machine likely to become obsolete within a short time?
4. Are custom operators available and reliable? Is this a less costly alternative than purchasing the machine?

The best kind of machine for the farm: A rule to follow in buying machinery is – ''Equip yourself (the farm) with basic power unit and tillage implements before purchasing specialized harvesting machines.''

3.3.1 MACHINE PERFORMANCE

Each piece of machinery must perform reliably under a variety of field conditions, or it is a poor investment regardless of its cost. Tillage implements should prepare a satisfactory seedbed while conserving moisture, destroying early weed growth and minimizing erosion potential. Planters and seeders should provide consistent seed placement and population as well as properly apply pesticides and fertilizers. Harvesting equipment must harvest clean, undamaged grain while minimizing field losses. The performance of a machine often depends on the skill of the operator, or on weather and soil conditions. Nevertheless, differences among machines can be evaluated through field trials, research reports and personal experience.

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.

Theoretical Field Capacity: 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. Knowing the work capacity of a particular tractor/implement combination is essential for determining field capacity and estimating earning potential. Based on 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. Field capacity is also useful for scheduling field operations on a daily, monthly and yearly basis.

The Field Capacity may be derived from the following Formula:

$$T_{\text{Field Capacity}} = \frac{Operating\ Speed\ \left(\frac{km}{h}\right) \times Working\ width\ of\ implement(m)}{10} = ha/h \quad \text{----------Equation 1}$$

As an example, take a tractor-mounted direct planter, 3-m working width, travelling at 5 km/h.

$$TC = \frac{speed\ \left(5\frac{km}{h}\right) \times Width\ (3m)}{10} = 1.5\ ha/h$$

Effective /Actual/ Field Capacity; The effective field capacity is the actual output achieved by a machine. It is a function of the proportion of the machine width utilized, the travel speed, and the amount of time lost in the field during the operation.

$$Effective\ Field\ Capacity\ \left(\frac{ha}{h}\right) = \frac{Area\ Covered\ (ha)}{Total\ Time\ Taken\ (Hour)} = \frac{A}{T} = \frac{W \times S}{10}\eta = \ldots\ldots \quad \text{Equation 2}$$

- $FC_E = SWLe/(10L + DSWLe + 2.778th)$ ..... Equation 3

- FCE is the effective field capacity (ha/h)
- S is the average forward speed (km/h)
- W is the implement design width (m)
- L is the average length of the field (m)
- e is the effective width of the machine (decimal of W)
- D is the unproductive time (h/ha)
- η – field efficiency (%)
- t is the time for a turn at row ends (seconds)

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. Field efficiency is achieved by ensuring that the unproductive time in machine operation is kept to a minimum.

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.

$$Field\ efficiency\ (\eta) = \frac{Actual\ (effective)\ Field\ Capacity}{Theoritical\ Field\ capacity} \times 100 \quad \text{.....Equation 4}$$

Practical; Measure field capacity and Field Efficiency of Farm Implement

Objectives

1. To measure field capacity of farm implements used on farm
2. To measure field efficiency of farm implements used on farm
3. Equipment Required:
   a. Tractor
   b. Disk harrow
   c. Cultivator
   d. Measuring Tape
   e. Stopwatch

Methodology:

Select an area of approximately 10 x 10 m for determination of field capacity and field efficiency of the implement. For theoretical capacity, take a test run of 10 m. Operate the farm machinery at optimum speed and at suitable gear in the field. Note down the average time taken by the implement to cover 10 m run. Also record average width coverage by implement in one pass. Find the theoretical field capacity to be covered by the implement based on width of the implement and speed of the implement using the formula, find the theoretical field capacity of the implement. For effective field capacity, operate the farm machinery to cover 10 x 10 m area taking into consideration of various time losses turning, refueling, adjustment, if any or any other time loss in the field. Operate the farm machinery in the selected field and note down the total time taken by the implement to cover 100 m2 area. Theoretical Field capacity: It is the rate of field coverage of the implement, based on 100 percent of the time at the rated speed and covering 100 percent of its rated width.

Ranges Of Typical Operating Speeds And Field Efficiencies For Some Machines

OPERATION	EQUIPMENTS	OPERATING SPEEDS, KM/HR (MI/HR)	FIELD EFFICIENCIES
Tillage	Moldboard Plow Chisel Plow Rotary Tiller Disk Harrow Field Cultivator	5.6-9.6 [3.5-6] 6.4-10.5 [4-6.5] 1.6-8.0 [1-5] 4.8-9.6 [3-6] 4.8-12.8[3-61	70-90 70-90 70-90 70-90 70-90
Cultivation	Row Crop Rotary Hoe Rotary Cultivator (Unpowered)	3.2-8.0 [2-5) 8.0-16.1 [5-10] 4.8-11.3 (3-7]	70-90 70-85 70-90
Seeding	Row Crop Planter with fertilizer Grain Drill	4.8-9.6 [3-6] 4.0-9.6 [2.5-6]	50-85 65-85
Harvesting	Mower Only Mower Conditioner (pull type) Mower Conditioner (self-propelled) Rake Baler Forage Harvester Combine Corn Picker	8.0-11.3 [5-7] 6.4-9.6 [4-6] 4.8-9.6 [3-6] 6.4-8.0 [4.5] 3.2-6.4 [2-4] 3.2-6.4 [2-4] 3.2-6.4 [2-4] 3.2-6.4 [2-4]	75-85 60-85 55-85 70-85 60-85 55-75 65-80 60-80
Other	Anhydrous Ammonia Applicator Field Sprayer Fertilizer Spreader	4.8-8.0 [3-5] 4.5-8.0 [3-5] 4.8-8.0 [3-5]	60-75 50-80 60-75

*From 1977 Agricultural Engineers Yearbook.

The starting point in any matching exercise is to determine the most critical field operation and to estimate the time available for completing a particular task. This will vary from region to region and often between farms within any one region. It is often determined by the time available to get over the area between rainfall events. Local knowledge or a check of local rainfall records will usually help in this regard.

The overall machinery capacity required is determined from the work volume (Area) it can handle per unit time.

The optimum machine (implement) size can be selected from two different perspectives:

1. It can be based on the amount of time available to complete an operation (Peak demand), or
2. It can be based on the amount of power available from the power source (tractor).

The process used depends on the situation.

When the limiting factor is time, the recommendation is to determine the available time (timeliness) for completing the operation of known area and then determine the size of machine required. Once the machine size is determined, the required tractor (Engine) size can be determined. A high priority on timeliness may result in a calculation that would require a larger tractor (power source) to power the machine.

When the limiting factor is power, the recommended procedure is to determine the maximum size of machine that can be powered by the tractor. When power is limiting factor, the calculations may result in a time requirement for completion of the activity that is not realistic.

Overall machine efficiency: Crucial for the profitability of a service provision business, the overall efficiency takes into consideration all factors affecting machine output (in addition to those related to field operation). It comprises the following factors:

Non-productive travel time: time spent by the machine travelling from one field to the next or from one farm to the next.

Working on small fields can lead to very high non-productive travel, as can working on different farms situated a long way from each other. If a machine is a long way from its base, then it may also be worthwhile for management to provide a fuel bowser to go around refueling machines.

Under-utilization: downtime can occur due to lack of sufficient work, bad weather, small plot size, etc. Achieving zero under-utilization is almost impossible; nevertheless, a principal goal of management is to ensure that machine utilization is maximized. The issue of land clustering and amalgamating farms for operation purpose could be an option.

Service or repairs: resulting in downtime. Management must schedule routine maintenance outside peak work periods. Although routine maintenance reduces the risk of unscheduled downtime, unexpected breakdown is also inevitable at some point and the immediate availability of spare parts is then crucial for minimizing downtime.

3.3.2 FIELD CONDITIONS AFFECTING MACHINERY PERFORMANCE

Weather patterns: The weather determines how many days are available for fieldwork in each time period. Both long-term weather forecasts and historical weather data are useful for assessing optimal machine capacity and making investment decisions.

- Insufficient capacity can lead to crop losses.
- extra investment is needed to have sufficient machine capacity for any eventuality.
- In many tropical climates, heavy rainfall during a short period may make it impossible to carry out agricultural work, especially mechanized work.
- Note that practicing zero tillage in a conservation agriculture (CA) regime and adopting an ecosystems-sensitive approach (climate-smart agriculture) help mitigate the effects of inclement weather patterns and climate change phenomena.

Field size: In general, the larger the field, the greater the field efficiency. Relatively long, narrow fields are also better than large wide fields, because the machine spends a greater percentage of its time working rather than turning at the ends of the field. The same tractor and implement effectively works 71% of its time on a 40-ha field and only 37% on a 2-ha field (Table 4).

Table 3. Relationship between field size and area covered by the same tractor.

	FIELD SIZE (HA)		
	2	10	10
Theoretical output (e.g. direct seeding with a small tractor) (ha/day)	12.6		
	LOSS IN OUTPUT (%)		
Losses due to turning in field	20	14	8
Losses due to turning at end of field	4	3	2
Losses due to moving between fields	22	7	2
Losses due to miscellaneous causes	17	17	17
Actual area covered (ha/day) (Theoretical output- Total losses)	4.6	7.4	9.0
Effective work as a % of the theoretical output	37	59	71

Table 4. provides an overview of the relationship between field size and area covered per day: the smaller the field, the less time a tractor spends performing the actual task.

Source: FAO & CIMMYT, 2018

Field shape and other factors: Field shape also affects tractor output, although not to the same extent as field size. Irregularly shaped fields are significantly less efficient than rectangular ones, as turning times are much higher. Long, relatively narrow, parallel fields offer the highest field efficiencies. Smaller tractors (including 2WTs) are more suitable for work in small, irregularly shaped fields.

Working pattern within the field: The work pattern of a machine within a field affects the working efficiency; a good operator should be trained and experienced in selecting the best method. In general, a continuously working machine is the most efficient. For implements that can only be operated in one direction (e.g., most disc ploughs), greatest efficiency is achieved by operating in "lands" (strips of land about 30–40 m wide) or by ploughing round and round from the outside edges of the field towards the center (or vice versa). Tined implements, no-till planters and combine harvesters, can work up and down the field from one side to the other.

Cropping patterns: The cropping pattern influences the machine capacity. Service providers require a thorough understanding of the prevailing cropping patterns in their area of work to be able to select appropriate machinery and schedule operations throughout the available seasons. Cropping patterns, such as a single, double, rotational, mixed or intensive (e.g., multiple or intercropping), determine the types of machinery required, work schedules and timing of operations. Land and seedbed preparation, sowing, planting and harvesting are the most requested operations for a machinery hire service provider. Figure 3.1 shows an example of a cropping pattern and highlights target dates for operations, including sequential operations for each crop.

Topography: In the context of agriculture, topography refers mainly to slope. Prevention of water run-off and erosion are of paramount importance, and it is crucial to avoid leaving the soil bare on sloping fields during periods of rain; techniques include direct planting and leaving crop residues in place. For draught animal power, good practice is to protect the hillside with contour barriers (of grass or shrub species) and to practice CA between the barriers. This prevents soil erosion, and the hillside can be used for sustainable crop production.

Figure 3.1 Farm operations and work periods needed to plan mechanization operations.

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Uproot cassava										
	Cultivate vegetables		Apply fertilizer								
Plough		Drill cereals	Plant cassava			Plough					
			Spray			Harvest cereals	Drill cereals	Harvest vegetables			
Goat herding											
Dairy production (grass cutting and transport)											

3.3.3 POWER REQUIREMENTS

In general, tractors are categorized according to engine power, measured in horsepower (hp) or kilowatts (kW) (1 hp = 0.746 kW). However, the actual performance of a particular tractor is rather more complex. For example, for towed implements, not only is the power of the engine important, but the weight of the tractor affects the load that can be pulled.

Besides the tractor's weight, other factors determine how much can be pulled. In general, the absolute maximum load that a wheeled tractor can pull when operating on soil is about two-thirds of its weight. Most tractors can increase the weight on the drive wheels by various means: filling the tires with water; adding wheel and front-end weights; and using the weight transfer gained by using three-point linkage mounted implements.

If, on the other hand, the tractor is to be used with implements powered by the PTO shaft (e.g., for rotary cultivator work in paddy rice), the engine power is the main deciding factor as it is applied directly to the working implement.

For most mixed agriculture applications, a general-purpose tractor with power between 40 hp and 100 hp offers the greatest flexibility. For paddy rice applications and for very small farms and field sizes, a smaller range of tractors can be considered (5–25 hp). Therefore, if a hire service has a client base of small farms with small fields, a 100-hp tractor may not be appropriate, as the machine could not be used to its full potential. Likewise, if general transport work accounts for a substantial part of the business, tractors with very low or very high power are not suitable; a more efficient tractor size is 50–70 hp. For an economic return, the average annual revenue earning usage of a medium-sized 4WT should be at least 700–800 hours. Ownership costs rise sharply when the annual usage falls below 700 hours.

- Horsepower Calculations: Calculating (drawbar) horsepower requirements for various tasks, considering factors such as soil type, draft resistance, and implement width.

$$P_{db\,(Kw)\,(at\ draw\ bar)} = \frac{Df(KN)\ XV(km/h)}{3.6} \quad \text{Equation 5}$$

$$P\ PTO\ (kW) = \frac{width(m)xspeed(kph)xdraft(kN/m)xsoilfactor}{3.6} \quad \text{Equation 6}$$

$$\text{Power (kW)} = \frac{\text{To} \times N}{9549} \quad \text{Equation 7}$$

- where kW = kilowatts; To = torque (Nm); *N* = speed (rpm).

Table 4. indicative power requirements for field operation

OPERATION	DRAUGHT POWER REUIREMENT
Mouldboard or disc plough	25 kW/m
Chisel plough or ripper	10 kW/m
Disk harrow	6 kW/m
Direct planter	2-6 kW/planting line

Figures in Table3 are for drawbar power, which takes account of forward speed. Note that- typically and depending very much on soil conditions- a tractor produces about half its engine power at the drawbar. Therefore, a 5-row direct planter requiring 5 kW/line needs at least a 50-kW (67-hp) tractor to pull it (5 lines × 5 kW × 2).

Allowance must be made for field efficiency. The formula then is (Equation 8)

$$Width\ (m) = \frac{area\ (ha)\ x\ 10\ (constant)}{time\ (hr)\ x\ speed\ (km/hr)\ x\ field\ efficiency} \quad \text{.....Equation 8}$$

Determination of Fuel consumption for selected operation- Fuel consumption is an essential factor to consider when calculating the cost for fieldwork with tractors, and this varies when working on different soil types and performing different operations. A simple and straightforward method to calculate fuel consumption of a tractor with an implement attached is the “Full Tank Method.”

Steps to calculate fuel consumption.

1. With the tractor turned off and standing on a flat surface, fill the fuel tank completely and take a visual reference point at the inner rim of the fuel tank.
2. Do the planned fieldwork and measure the time it takes to finish a specific area.
3. Park the tractor on the same flat surface as before and turn off the engine.
4. With a measuring cup, fill the fuel tank up again to the same reference point, and note the amount of fuel added to reach this point.
5. Divide the added fuel volume by the field surface area worked to calculate the fuel consumption per surface area

$$Fuel\ consumption\ (l/ha) = \frac{\text{Added Fuel Volume } (l)}{\left(\text{Field Surface Area } (m^2)/_{10\,000}\right)}$$

6. Divide the volume of the fuel added by the time elapsed in seconds during fieldwork and multiply by 3 600 to calculate the fuel consumption per hour.

$$Fuel\ consumption\ \left(\frac{l}{h}\right) = \frac{\text{Added Fuel Volume (l)}}{Elapsed\ time\ on\ field\ (s)} * 3\,600$$

Identify your 'priority critical field operation

Estimate the time you'll have available to complete this priority task

Determined the required field capacity in ha/hr

Divide this by field efficiency to obtain the theoretical field capacity

Use typical operational speed values from literatures

Divide the T.F.C with typical field speed to get the required width of operation

Width = machine width X number of bottoms

Select the required implement width and number of bottoms combination matching your requirement

Draft requirements will vary with implement design, soil type, speed and depth of operation. Therefore, in any matching situation there is an inherent danger in specifying a machine's capacity or power requirement unless actual field efficiencies and draft requirements have been measured. Accept specifications, therefore, with some caution.

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3.4 OTHER FACTORS AFFECTING MACHINERY SELECTION.

Availability and Skills of the Tractor Operator

In recent years, tractors have become increasingly sophisticated machines; it is, therefore, essential to consider availability as well as the time involved, and costs implied in tractor operator training.

Flexibility

Another major consideration is the degree of flexibility needed. If the hire service has four small (rather than two big) tractors, it can carry out a greater number of field operations; moreover, if one machine breaks down, business capacity is reduced by just 25 percent– compared with 50 percent when one out of two larger machines break down. On the other hand, four tractors require four operators, entailing greater costs.

Machine Make and Dealership

It is important to choose the most suitable make of tractor: the right or wrong decision can make or break a hire service business. Note that different makes of machine dominate in different markets. Asked why a particular machine is dominant, owners and operators insist that it is the best machine on the market. In a neighboring country or region, a different make is declared the best. The reasons can be quite complex but are often to do with the level of dealer support a given make receives. A hire service should research the level and quality of service provided by dealers.

Field Performance

Estimation of the actual performance of implements in the field is not always a straightforward matter. It depends on concepts such as field capacity and field efficiency and these, in turn, depend on many other factors. Indicated formulas can be used to estimate field performance of a machine and thereby, making

selection of the optimum machine size.

Purchase Price and Costs

When considering the sales price of a tractor, compare prices among the various makes and dealerships available in the local area. Consider the various services provided. For example, one dealership may present a low sales price but offer few services, while another dealership may place a higher sales price on the same tractor but include a wider range of services. Credit may be offered by the dealership to support the purchase of a tractor; credit products and schemes need to be carefully assessed.

Some implements perform multiple operations. This is not the case for all implements – for example, a ripper provides ripping services only. Trailers, on the other hand, may provide a wide range of services in differing settings and this must be considered when considering the purchase price and the running costs.

The purchase price varies considerably depending on the type of implements considered and whether they are for tractor or animal power sources. Consider the price of an implement in relation to the services it can provide and the revenues it will generate.

Implements, like tractors, will lose value over time, i.e., they depreciate. Furthermore, they need to undergo regular maintenance and be repaired as necessary. Both fixed and variable costs must be considered in the selection process.

Spare Parts Availability and Service Support

It is fundamental to have access to good quality, reasonably priced replacement parts and high-quality technical service. A cheap tractor or implement can prove an expensive option when it breaks down, is not supported by a spares and service back-up, and cannot be used to generate the income expected because it is broken and sitting idle in the farmyard. Availability of trained operators and mechanics and their ethics are very crucial to be confirmed.

Finance

Implements may not be as expensive as tractors; nevertheless, small-scale hire services may still need to find ways to finance their initial investment. If savings are available or the hire service has enough cash to provide for the investment within the business, a loan is not necessary. However, when cash is not available, sources of financing need to be identified. Sources of financing may be family members, local finance institutions (e.g., NGOs, bank loans and grants). A loan assessment takes into consideration:

- Collateral (assets) required to guarantee the loan.
- Interest rates (loans for implement acquisition are typically short term, i.e., with a higher interest rate); and
- The payback period.

A loan appraisal is designed to ascertain whether the hire service can cover the interest rates and respect the payback period. It examines the cash flow, based on the amount of money earned in each period (e.g., 1, 2 or 6 months) and the amount of money spent. Based on the monthly cash balance of the hire service, for example, it is possible to verify whether the time frame of the loan payback period is realistic. By determining its cash flow, a hire service can identify the times in the year when the hire service business may run short of cash and thus plan to raise the cash needed in time to pay back the loan instalments.

3.5 FINANCIAL ASPECTS OF FARM MACHINERY MANAGEMENT

Farm machinery management is a section of Farm Management that deals with the optimization of the equipment phase of agricultural production. It is concerned with the efficient selection, operation, repair and maintenance replacement of machinery.

Machinery management is an integral but vital aspect of successful agricultural mechanization scheme. Effective machinery management implies effective decision making and implementation in all aspects of selecting operation, making right choice on equipment, ownership, appropriate power-implement match, operation financing and controls on machinery utilization for optimum output. Evidently, today's agricultural market is rapidly growing in the face of dwindling oil reserves and ailing capital markets. As such, agriculture becomes more competitive and requires operating costs minimization and better resource management to maximize profit. Increased machine capacity and efficient utilization of production factors could encourage major cost

reduction.

Financial analysis of the intended machinery hire business must be carried out before an investment is made. 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 equipment in the hire service.

It is thus essential to prepare a proper Business Plan (Covered in separate topics) 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.

Consider what services are demanded locally and how much can be charged. Carry out a market assessment to gather this information (Section 2), together with data on soil types, farm sizes, land preparation and post-harvest services required. You will then have an indication of what power (hp) the tractor needs to have. Set feasible prices for the services required to calculate potential earnings and, consequently, to determine what kind of tractor the hire service can afford. This information (prices, and what services are needed and when) is also useful for estimating the cash coming into the hire service (revenue) and the cash being paid out of the hire service (expenses). It is important to understand this cash flow to know what the hire service can afford in terms of repayments if it needs a loan to purchase a tractor.

The relationship between cost and returns is very important to be known ahead of investment decision. Annual fixed and operating costs are assumed when we buy the machinery. One should also determine whether there might be any reduction in gross income with the purchased machinery as compared with the alternative method of getting the work done. Comparing the increased cost and increased returns will give a clue for justifying purchase of new machine for hire service.

Machinery operational Costs can be divided into two categories: fixed or ownership and variable or operational costs.

3.5.1 OWNERSHIP OR FIXED COSTS

Machinery ownership costs include charges for depreciation, interest on investment, property taxes, insurance and machinery housing. These costs increase in direct proportion to machinery investment and size.

1. **Depreciation** is loss of value over time. It is a non-cash expense to reflect a loss in value from age, wear, tear and obsolescence. It is often the largest cost of farm machinery, measures the amount by which the value of a machine decreases with time, whether the machine used or not. At the end of its useful life, an old tractor or implement has “scrap value”, i.e., it is worth as much as a purchaser will pay for it. Calculate depreciation (Straight-line method) by dividing the difference between the purchase price and the scrap value of the machinery by useful life (SL method):

Annual depreciation (Birr)= (Purchase price (br)-Scrap value(br))/(Useful life (Years)) *Equation 9*

2. **Interest:** Interest in capital is another fixed cost item. The options for a person wishing to invest in machinery are by saving or by borrowing money. In both cases there is a cost. This is the cost of borrowing and is known as the interest rate. If a businessman uses his own savings there will be no need to pay the interest on a loan. But on the other hand, neither can he invest that money in a way that will earn them interest. So, in both cases there is a cost, although in the second case it is a lost opportunity and so is called an opportunity cost.

Interest is calculated on the average investment of the tractor taking into consideration the value of the tractor in first and last year.

$$\text{Annual interest charge \$} = \frac{\text{Purchase price (\$) + scrap value (\$)}}{2} \times \text{i (\%)} \qquad \text{--Equation 10}$$

$$\frac{(C+S)}{2} \times \frac{i}{H}$$

Where, I is the interest per hour , i is the % rate of interest per year

3. **Housing:** Housing cost is calculated based on the prevailing rates in the locality. In general, it may be taken as 1% of the initial cost of the tractor per year.
4. **Insurance:** Insurance charge is calculated based on the actual payment to the insurance company. In general, it may be taken as 1% of the initial cost of the tractor per year.
5. **Taxes:** Taxes is calculated based on the actual taxes paid per year. In general, it may be taken as 1% of the initial cost of the tractor per year.

There may be some other fixed costs associated with machinery use, and these will need to be investigated and quantified for specific circumstances. Items can include:

- Government taxes (on tractors, for example).
- Insurance against theft or loss.
- Shelter for machinery when not in use.

3.5.2 OPERATING OR VARIABLE COSTS

Variable costs are those costs which change (vary) with the level of services provided. Variable costs vary as the service business expands to serve more customers and the number of hours served or hectares covered through machinery hiring increase. Variable costs cover things like fuel, hired labor (operator's) costs, and repairs and maintenance. Variable costs are not incurred if the machinery is not used. The more the machine is used the larger the variable costs.

Operating costs per acre change very little as machinery size is increased or decreased. Using larger machinery consumes more fuel and lubricants per hour, but this is essentially offset by the fact that more acres are covered per hour. Much the same is true of repair costs. Thus, operating costs are of minor importance when deciding what size machinery is best suited to a certain farming operation.

Maintenance and Repairs

Maintenance and repair costs of agricultural machinery fluctuate considerably from machine to machine because of different working conditions, operator skills, care for regular servicing, quality of the make and model etc. The cost of maintenance and repairs also varies according to the life of the machine. Repair costs increase with usage and are on average higher the older the machine gets. Maintenance costs include some small charges for housing and insurance, and charges for repairs, spare parts and servicing.

A simple method of assessment of the repair costs is to estimate the item as a percentage of the initial cost of the machine divided by the number of hours of machine life.

Operator costs

Operator cost may be fixed or variable, depending on whether the operator is a full-time employee (paid whether operating machinery or not) or someone employed only for actual work with the equipment. The greater the machine capacity, the lower the operator costs per unit of work carried out (hour or unit of area). In the case of a full-time operator, the more work done, the lower the cost per unit. However, in terms of cost, skilled operators cannot be treated in the same manner as unskilled labor: it is in the interests of the hire service business to invest in experienced, skilled operators.

Fuel

The cost of fuel is simply calculated based on the number of litters used per hp. of operation. For diesel engine tractors the standard rate is 0.12 liters per hp hour. and for an average 14 h.p. machine it is 0.2 liters per hour. This figure would be multiplied by the cost of diesel fuel per liter to get the total fuel costs per hour. Lubricants are charged at around 6% of the cost of fuel.

Table 5. Worked Example cost estimation.

BOX 1: ESTIMATION OF THE COSTS OF OPERATING A 2-WHEEL (15 HP) TRACTOR	
Purchase price: $2,500	Useful life: 5 years
Residual value: $500	Annual use: 800 hours
Interest rate: 12%	Price of diesel fuel: $1.4 per litre
ANNUAL FIXED COSTS	
Depreciation (2,500-500) /5	$400
Interest ((2,500+500)/2) x 0.12	$180
	Sub-total: $580
ANNUAL VARIABLE COSTS	
Repairs and maintenance/ hr. (0.35 a × 2 500) ÷ 4000	$0.218
Fuel ($1.4/ litre) x 1.68 litres/hourb	$2.3
Labour ($6.25/ day)	$0.78
	Sub-total: $3.298
Hourly Fixed Costs	0.725
Hourly Variable Costs	3.29
TOTAL HOURLY COSTS	4.02
• Repair and spares estimated at 35% of purchase price over the useful life of the tractor. • Tractor fuel consumption – 0.22-0.11litter/h/hp of diesel (break hp) • Average fuel consumption 0.165 l/hp/h or 0.124 l/kWh (BHP) Fuel use: 0.12 liters/ hp. (Used for this calculation)	

Equipment Item procurement cost (New or second hand)

Expected duration of ownership in years (economic life)

Expected value on disposal after ownership, or scrap value

Expected annual productive utilization (in hours or days)

Assumed number of productive hours utilization per day (except small items)

Finance or Opportunity Cost of capital deployed (as an annual interest rate)

Estimate or record of value of spares consumed per year for the equipment item compared to cost new and reduced to a daily charge

Estimate or record of value cost of servicing and repair workshop costs per year for the equipment item and reduced to a daily charge

Estimate or record of fuel and lubricants consumption and costs per hour/day of utilization

Costs of operator's and assistant's wages, allowances or other costs, reduced to a daily charge

All cost components relating to overheads to be assigned to the equipment item over the course of the operating year and reduced to a charge per operating day.

Table 6. Estimated life of Farm Machinery and estimated repair costs as a percentage of new Costs.

MACHINE	TOTAL SERVICES (HR)	REPAIR AS PERCENT OF NEW COSTS	
		FULL LIFE[A/]	3/4 LIFE[B/]
Baler, with engine	2,500	60	40
Baler, PTO	2,500	80	54
Blower, ensilage	2,000	80	54
Combine, PTO	2,000	100	67
Combine, SP	2,000	60	40
Corn head	2,000	100	67
Corn picker	2,000	80	54
Cutter, rotary	2,000	60	40
Cutter, stalk	2,000	60	40
Forage harvester, pull-type	2,000	80	54
Forage harvester, SP	2,000	60	40
Hay conditioner	2,500	100	67
Manure spreader	2,500	60	40
Sprayer, mounted	1,200	100	67
Sprayer, SP	2,000	80	54
Swather, SP	2,500	100	67
Tillage (plows, planters, cultivators, and harrows)	2,500	120	83
Tractor, 2-wheel drive	12,000	120	78[C/]
Tractor, 4-wheel drive	12,000	100	65
Tractor, crawler	12,000	100	65
Truck, farm	2,000	80	54
Truck, pickup	2,000	60	40

A/ Based on Agricultural Engineers Yearbook.
B/ Calculated by using formulas in Agricultural Engineers Yearbook.
C/ For 9,000 hours spread over 12 years, this would average 6.5 percent per year.

(Source Donnell H., 1995)

In many cases, crop yields and quality are affected by the dates of planting and harvesting. This represents a "hidden" cost associated with farm machinery, but an important one, nevertheless. The value of these yield losses is commonly referred to as "timeliness costs."

Total Machinery Costs

Illustrates the effect that changes in machinery size have on each type of cost in a typical situation. For very small machinery (relative to crop acres), a slight increase in machinery size can lower timeliness and labor costs significantly, enough to more than offset the higher fixed costs. However, as machinery size continues to increase, the timeliness cost savings diminish, and eventually total costs begin to rise. One objective of machinery selection, then, is to select machinery in the size range where total machinery costs are lowest. The correct and appropriate selection of a power source and equipment determines 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.

3.6 APPROACHES FOR REDUCTION OF MACHINERY COST

The most critical success factor in reducing machinery costs is to increase the utilization rate of the machine. Downtime needs to be kept at a minimum by proper operation and maintenance scheduling. 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 programs 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 (Clustering).

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 encouraging farmers to increase field sizes through land consolidation.

Working with farmers practicing similar cropping patterns

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.

Introducing incentives for careful and skillful operators who have fewer breakdowns and high work rates.

3.7 SETTING HIRING CHARGES

- Custom hiring is a way of spreading the fixed costs of machinery over a larger area and thereby reduce per unit costs charged to smallholder farmers. Determining the rate to charge for machinery services is vital to ensure sufficient revenue is generated to ensure profits. Setting hiring charges, however, can be difficult for service providers due to the wide range of machinery items on the market and the knowledge needed to ensure that all costs are covered in the calculation.
- The range of hire services that can be offered are many and each of them has a potential for making profit. However, each one of these services offered also has costs which need to be estimated. Farmers who are considering buying machinery need to compare the costs of owning their own machines with the costs of custom hiring.
- This type of calculation is a little complex and may require the collection of data recorded over time. Many farmers and businesses may not have the data and may have to rely on standards produced by research organizations.
- A key calculation is the work rate for various items of machinery. This is the number of hours per hectare or hectares per hour that a machine can conduct a farm operation.
- Work rates are calculated based upon the implement's working width and its travel speed.
- However, in all field operations there is a difference between the basic work rate and the actual work rate. This is referred to as field efficiency. Field efficiency can vary greatly depending upon work conditions (field size and topography, soil or crop conditions, suitability of the equipment for the task, and availability of support equipment.
- Custom hire rates- In countries where a market exists for mechanization services, market rates can be found from assessing hire charges in the rural area. All too often custom rates do not represent the full cost of the machinery to the owner.

Calculating hiring charges: The first step in determining appropriate hiring charges is to define the machinery cost. The following is a brief discussion of each of the costs.

NB: on top of these efforts, participation and consent of Customer and extension unit is very essential.

Fixed costs

- Depreciation
- Interest on investment
- Taxes, Insurance, and road license
- Shelter costs

Variable costs

- Labor
- Fuel and lubricants
- Spare parts or M&R

Table 7. Formulas for Estimating Annual Machine Costs.

Cost	Formula	Rule-of-thumb figures (%)
Depreciation	$\frac{\text{Purchase price} - \text{Salvage value}}{\text{Estimated years of life}}$	7 to 15
Interest	$\frac{\text{Purchase price} + \text{Salvage value}}{2} \times \text{Interest rate}$	3.5 to 7.0
Taxes	$\frac{\text{Purchase price}}{2} \times .55 \times \text{Tax rate}^{1/}$	1.0 to 1.3
Insurance	$\frac{\text{Purchase price}}{2} \times \text{Insurance rate}$	.3 to .4
Repairs	(Purchase price × Total repair cost as a percent of new cost) ÷ Hours to wear out × Hours of annual use	3 to 8
Shelter	Purchase price × (.5% to 3.5%)	1.5

1/ Refers to property tax.

On the average, the following percentages of the new costs should cover annual costs except fuel oil and grease and labor of the operator; Tractor and harvesting equipment 22% and tillage equipment 20%. Here are examples how these figures might be distributed among the various cost items assuming that shelter is already available.

Cost Item	Equipment		
	Tractors	Harvest	Tillage
Depreciation	9.0%	10.0%	7.0%
Interest[1]	5.0	5.0	5.0
Shelter	1.5	1.5	1.5
Repairs	6.0	5.0	5.5
Insurance	.4	.4	.4
	21.9%	21.9%	19.4%

[1]Based on rate of 10 percent on average value throughout life of machine

Once the fixed and variable costs are estimated, they will have to be brought to a common basis to calculate the hiring charge costs. This could be hectares or hours of use.

Whilst this calculation considers the actual costs of operation, mechanization hiring service providers need to add a margin for profit and management. Service providers don't want to work for free and they also know that making money above their costs will also enable them to have money to maintain their machinery regularly, repair them if the needs arises and possibly have money to save. They should also know that they must get their "salary" for doing this job. Service providers need to make a profit.

3.8 BREAK-EVEN ANALYSIS

Break-even analysis is an analysis to determine the point at which revenue or income received equals the costs involved. It is a technique for studying the relationship between costs and income at different levels of output. A break-even budget estimates the maximum acceptable level of a cost, or the minimum acceptable level of an income given an estimated level of cost.

In the context of the hire service business, the break-even point looks at the level of the service where total revenue equals total cost i.e., the point where no profit (margin) is made. Break-even occurs where total cost and total gross income are equal.

The break-even rate is the minimum level of operations that are needed to cover the costs of service provision. The break-even calculation is made by dividing the annual fixed costs by the difference between the custom hire rate per unit (hr./ ha.) and the variable costs of operations per unit (hr./ ha.).

Break-Even Point =(Total Anual Fixed cost of machine)/ (Custom hire rate per hr-Variable cost per hr)

Equation 11

Example Break-Even Point Calculation

- Annual fixed costs = $1,134.
- Custom hire per ha. = $30
- Variable costs per ha. = $20

Break-Even Point =(Total Anual Fixed cost of machine)/ (Custom hire rate per hr-Variable cost per hr)

Break-Even Point =1134$/(30$/ha-20$/ha)=113ha (Implies that seasonal area coverage should be more than this)

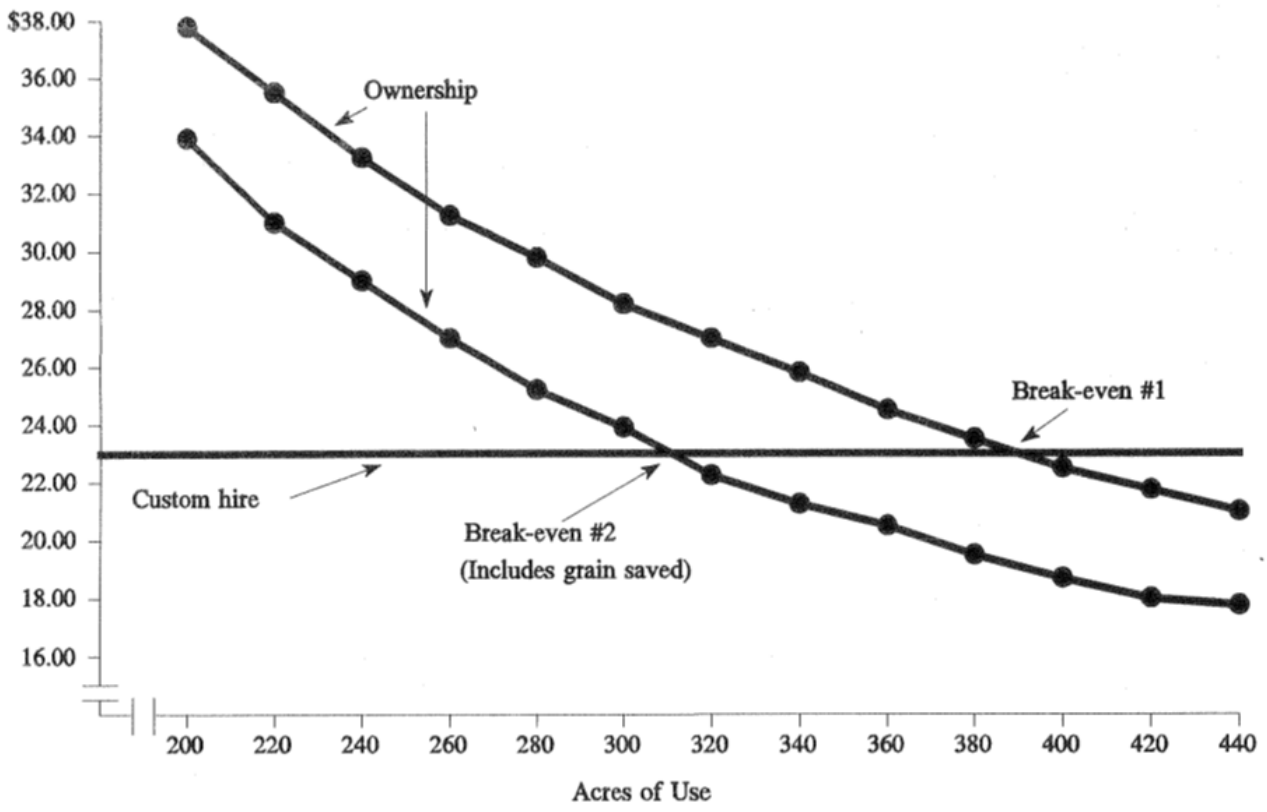


Figure 3. Break-even point between owning a combine and hiring custom work.

3.9 LIFECYCLE COST BENEFIT ANALYSIS

Life Cycle Costs are those costs incurred on a machine during its lifetime, or a part of it. All costs incurred in the life of owning or hiring a machine must be considered before purchase or hire of the machine or equipment. It is very important to carry out a general lifecycle cost analysis or analyses of Total Costs of ownership before making decision to own a machine for hire service. Lifecycle analysis will help to 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.

3.10 FINANCING MECHANIZATION

Mechanization is costly: there is the initial investment in purchasing a tractor, or a pair of oxen, and the implements to go with them; and then there are running costs, maintenance costs, and the need to have sufficient capital ultimately to replace worn out equipment. How can this be financed? Some of the possible ways for financing mechanization are:

- Joint ownership
- Borrowing
- Improving the Options
- Leasing
- Micro credit

3.11 PURCHASE PROCESS

In many countries, especially where there is little competition between agricultural equipment suppliers, the choice of a tractor (or other agricultural and post-harvest machinery) depends on availability in the local market and (critically) availability of spare parts and repair services. The ready availability of spare parts is crucial for a highly

weather-dependent business such as agriculture. Some manufacturers give financial incentives and special warranties to attract purchasers; it is, therefore, worthwhile "shopping around". Dealerships offer credit products, which may be used as a guarantee for the loan; for example, a tractor itself may be used as collateral. Before deciding to purchase a particular make and type of machine, establish whether support services are available. This may be a determining factor in any purchasing decision and its importance cannot be overestimated.

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, including their assessment, with a focus on the purchasing aspects. It is necessary to prepare for the field visit and then return to the training setting to develop a complete checklist of criteria for selecting mechanization inputs.

Prior to the purchase, ask the dealership:

- Is the equipment currently available in-store? If not, how long will it take for it to be available?
- Are spare parts supplied? If so, what is their quality, availability and cost? If not, where can they be found?
- What is the warranty period for the machine and what, specifically, does the warranty cover?
- Is there a maintenance and repair service? If so, what is its quality, reliability and cost? If not, where can a repair service be accessed?

Different brands dominate in different markets. If you ask owners and operators why a particular machine is dominant, they assure you that it is the best machine on the market. In a neighboring country or region, owners declare that another make is the best. It is human nature not to admit that a wrong purchasing decision has been made. Nevertheless, there are other reasons why a brand is popular in some markets and not in others, notably the level of dealer support provided. When spare parts are readily available, downtimes are kept very short, leaving the impression that the machine in question rarely breaks down. The dealer therefore sells more machines until the make in question dominates the market and it becomes difficult for other makes to compete.

Furthermore, many owners are "prejudiced" in favor of a particular make – a sentiment that cannot be explained on logical or rational grounds. A purely rational purchasing decision-making process (as outlined above) rarely exists. Participants should be aware of these factors and take them into consideration in the decision-making process.

Common aspects to be considered while evaluating and selecting different agricultural machinery with proper.

- Reputation of the brand, the model, the manufacturer, and the dealer.
- After sales service and maintenance facilities
- Manufacturer standards
- Warranty type and time
- Spare part availability
- Horsepower required to operate the implement.
- The overall weight of the tractor and implement together with the hydraulic lifting capacity.

3.12 MACHINERY MAINTENANCE MANAGEMENT

3.12.1 WHAT IS MACHINERY MAINTENANCE?

Maintenance is the practice of keeping in form or shape of equipment, machine system or object in its original status as much as possible. Note that maintenance is not repairing a machine after it breaks or when it stops work (Frank Buckingham 1981). It is a means of achieving optimum value for equipment to perform its desired and designed functions. Thus maintenance is protecting a machine so that it does not break down or wear out quickly. Proper maintenance protects machines from the following enemies.

1. Wear (grease and oil are used to protect machines from wears)
2. Dirt (Filters are used to catch and hold dirt before it gets inside and damages parts)
3. Heat (The cooling and lubrication systems protects the machine from heat)

Regular maintenance is one of the prerequisites for a long living and reliable engine performance. The recommended engine servicing procedure is contained in the Owners Handbook for each engine model. Additional servicing is often necessary and depends on the type of operation the engine is

subjected to.

Good maintenance practices are essential for efficient operation of all types of machinery.

3.12.2 SERVICE MANUAL & REPAIR MANUAL

- Service manuals often include additional troubleshooting tips, routine maintenance hints, and model-specific repair information not found in the Official Factory Repair Manual.
- The Official Factory Repair Manuals contain repair information that the dealer-trained service technicians use every day. The information is developed by the manufacturer primarily for the professionally trained technician. The Official Factory Repair Manuals usually contain more information than the service manuals and assume a high level of automotive experience and skill.

3.12.3 DIFFERENCE BETWEEN MAINTENANCE AND REPAIRS

1. To repair something is to fix something that is broken. To keep maintenance on something is to keep it well kept so it doesn't break.
2. Repairs are services that are required or necessary when something on your vehicle is not working properly or may have worn to the point where a replacement is required to maintain the performance of your vehicle.
3. Maintenance is the routinely scheduled services, inspections and part replacements that your vehicle manufacturer recommends based on the age or mileage of your vehicle.
4. The schedule for performing these maintenance services varies from vehicle to vehicle. You will find the schedule for your vehicle in your owner's manual. Following this schedule is the best way to make sure your vehicle is performing as it should.

Farm machines start deteriorating as soon as they are manufactured. Some of the deterioration is due to exposure to environmental factors as air, sunlight, and moisture. Iron rusts. Rubber oxidizes. Plastics and paints age. Such deterioration is retarded by storing machines in a dark shelter. But the most significant deterioration is from the use of the machine.

The process of retarding or correcting deterioration is called maintenance. Repair costs are those expenditures for parts and labor to install replacement parts after a failure and to recondition renewable parts because of mechanical wear.

The machinery manager is interested in performing those repair and maintenance activities that ensure reliability of the machine. The costs of downtime during critical field operations may appear to be so great that over maintenance and repair is looked upon as prevention and worth the cost.

With increasing automation and mechanization agricultural operation processes are shifting from manual to machineries. Consequently, the role of equipment maintenance in controlling quality and costs is more evident and important than ever.

Unlike land or buildings, machinery must be continuously monitored, maintained, and eventually replaced. In most cases costs of owning and operating of farm machinery represent 35 to 50% of the costs of agricultural production.

The main objective of proper machinery maintenance is maximizing the performance of machinery and prolong the life of capital equipment; there by, enabling maximum utilization of equipment and high rate of return on investment. It is also related to profitability through increased equipment output and decreased running cost.

3.12.4 TYPES OF MAINTENANCE

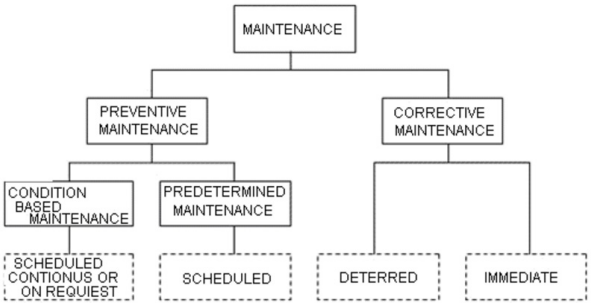
- The amount of service required from the equipment and resultant cost determines maintenance philosophy.

1. **Breakdown maintenance:** The equipment is run until it breaks down or its performance is unacceptable.
2. **Preventive maintenance:** Preventive maintenance is an action involving inspection, servicing, repairing or replacing physical components of machineries, plant and equipment by following the prescribed schedule. It is systemic and periodic inspection and servicing required to keep equipment in proper operating condition. It means fixing things before they break.

(Planned replacement)

4. **Forced/Corrective/ Maintenance (CM):** repair/replacement of parts that failed (unplanned replacement)

- **Routine Maintenance:** Is the simplest but very essential form of planned maintenance. it is carried out at regular intervals. It involves periodic check of relevant areas. The frequency of such checks ranges between hourly, daily, weekly and monthly or as recommend by the manufacturers. Routine maintenance reduces fuel bills and extends equipment life.



Source; Segun R. Bello, 2008

3.12.5 PROPER MACHINERY MAINTENANCE

The term preventative maintenance is given to the periodic service of the machine as recommended by the manufacturer. Changing of lubricating and hydraulic oils; cleaning or replacing fuel, oil, and air filters; and replacing or refurbishing implement parts subject to rapid and predictable deterioration are performed in the belief that scheduled maintenance will prevent future failure.

The main objectives of Planed Maintenance are.

- To ensure maximum availability of plant, equipment and machinery for productive utilization through planned maintenance
- To always maintain machine and equipment and facilities at an economic level of repair to conserve these and increase their life spans.
- To provide the desired service to operating departments at optimum levels through improved maintenance efficiencies
- To reduce cost of the lost production due to breakdown.
- To provide management with information on the cost and effectiveness of maintenance.

3.12.6 IMPORTANT STEPS FOR A PREVENTIVE MAINTENANCE

Reasons for preventative maintenance (PM)

- Identifies wearing problems or damage before they become serious.
- Saves money and time from costly breakdowns.
- Extends life of machinery and equipment
- Maintains horsepower.
- Allow better planning and scheduling of needed maintenance work.
- Increases trade-in or salvage value.

To develop an effective preventive maintenance program, the availability of several items is necessary. Some of those items include.

- Accurate historical records of equipment,
- Manufacturer's recommendations,
- Skilled manpower,
- Past data from similar equipment,
- Service manuals,
- Unique identification of all equipment,
- Appropriate test instruments and tools,
- Management support and user cooperation,
- Failure information by problem/cause/ action,
- Consumables and replaceable components/parts, and clearly written instructions with a checklist to be signed off.

Study operator's manual: In the manual you will find information such as:

- **Maintenance Schedule.** This will tell you about the intervals for routine maintenance, including engine, transmission, and hydraulic oil change, filter changes, and other maintenance items.
- **Specifications.** This should be a table telling you the type of fluid for the transmission, hydraulic system, brakes, and engine coolant, as well as their capacities. Tire inflation, bolt torques, and other information may be found under specifications or other sections of the manual.
- Location of lubricant points (grease fittings), fluid check dipsticks or sight glasses, and instructions on cleaning air and fuel filters.

3.12.7 GENERAL MAINTENANCE GUIDELINE

The following guidelines provides general standard practices to safeguard the functioning and longevity of agricultural machinery. Specific maintenance schedules and procedures may apply, depending on the type and brand of machinery.

Preventive maintenance is a standard practices which helps to safeguard the functioning and longevity of the agricultural machinery. This type of maintenance consists of a set of activities to improve the overall reliability and availability of a system. All kinds of systems, in agricultural machineries, have prescribed maintenance schedules expressed by the manufacturer that attempts to decrease the risk of system breakdown and the total cost of maintaining the system. In general, preventive maintenance activities include inspection, cleaning, lubrication, adjustment, alignment, and/or replacement of sub-systems and subcomponents that are fatigued. Sample lubrication and maintenance plans for agricultural Tractor, Implements and Combine Harvester as presented on the tables below as well as the service interval and maintenance operation, highly depend on the brand and level of technology.

Schidule for machinery Maintenance services

SERVICE INTERVAL	OPERATION N°	MAINTENANCE OPERATION	CHECK	CLEANING	LUBRICATION	REPLACEMENT	ADJUST	DRAIN
When a warning symbol appears	1	Engine air cleaner outer element	■	■				
	2	Fuel filter/water separator	■					■
Every 10 hours/ daily	3	Engine coolant level	■				■	
	4	Engine oil level	■				■	
	5	Windscreen washer reservoir fluid level	■				■	
	6	Brake fluid reservoir level	■				■	
	7	Oil level in steering circuits	■				■	
Every 50 hours	8	Radiator, intercooler, oil cooler and air conditioner condenser	■	■				
	9	Cab air filters		■				
	10	All grease fittings			■			
	11	Front and rear wheel nut torque	■				■	
	12	Tyre pressures and condition	■				■	
Every 100 hours	13	Air brake compressor drive belts (where fitted)	■					
Every 300 hours	14	Battery electrolyte level (tropical climates)	■	■			■	
	15	Poly V-belt	■					
	16	Transmission/rear axle/hydraulics oil level	■				■	
	17	Handbrake and electronic park brake (EPB) (where fitted)	■				■	
	18	Front PTO gearbox oil level	■				■	
Every 600 hours	19	Engine oil and filter				■		
	20	Charge pump oil filter				■		
	21	Engine air cleaner outer element				■		
	22	Engine air intake connections	■					
	23	Transmission cooler couplings	■					
	24	Pre—fuel and secondary fuel filter elements				■		
	25	Four-wheel drive front axle and hubs oil level	■				■	

SERVICE INTERVAL	OPERATION Nº	MAINTENANCE OPERATION	CHECK	CLEANING	LUBRICATION	REPLACEMENT	ADJUST	DRAIN
Every 1200 hours/ annualy	26	Cab air filters				■		
	27	Transmission main filter cartridge and charge pump oil filters				■		
	28	Transmission/rear Oil				■		
	29	FWD axle differential oil	■			■		
	30	FWD axle hub oil				■		
	31	Front PTO gearbox oil				■		
	32	Battery electrolyte level (temperate climates)	■	■			■	
	33	Engine coolant — conventional type coolant				■		
	34	Engine air cleaner inner element				■		
Every 1200 hours/ annualy	35	Engine valve tappet clearances	■				■	
	36	Engine breather filter				■		
	37	Air brake dryer reservoir				■		
Every 3 years Every 3600 hours or 4 years General maintenance	38	Air conditioning system	■	■		■		
	39	Engine coolant — OAT type coolant				■		
	40	Fuel system pre—filter and water separator	■	■				■
	41	Hydraulic system hoses	■					
	42	Bleeding the fuel system	■				■	
	43	Transmission calibration	■				■	
	44	Footbrake pedal latching	■				■	
	45	Automatic pick-up hitch	■				■	
	46	Remote control valve drains bottle(s)	■					
	47	Cab suspension adjustment	■				■	
	48	Headlight and work lamp adjustment	■				■	
	49	Bulb replacement				■		
	50	Fuse and relay replacement				■		
		Cleaning the tractor	■	■				
		Protecting electrical systems	■					
		Storing the tractor	■	■	■		■	

Source Buyers' Guide for Agricultural Machinery in Ethiopia, GIZ

Table 9. Lubrication and Maintenance service schedule for farm implements

SERVICE INTERVAL	OPERATION N°	MAINTENANCE OPERATION	CHECK	CLEANING	LUBRICATION	REPLACEMENT	ADJUST
Everyday	1	Dust/soil and mud on the implement					
	2	Moving parts					
	3	Fittings, bearings and all grease nipples before starting work					
	4	Grease nipple					
	5	Moving parts like piston, discs, hydraulic hoses					
	6	All bolts and nuts					
	7	Three-point linkage or drawbar connection / connecting road					
	8	Hydraulic connection and spool valve					
General maintenace	9	Wearied parts (disc, tip, nozzle, hose, bolt, bearing etc.)					
	10	Damaged parts (hydraulic spool valve, piston, bearing etc.)					

Source Buyers' Guide for Agricultural Machinery in Ethiopia, GIZ

Table 10. Lubrication and Maintenance service for Combine Harvester

SERVICE INTERVAL	OPERATION N°	MAINTENANCE OPERATION	CHECK	CLEANING	GREASE	LUBRICATION	REPLACEMENT	ADJUST	DRAIN
Every 10 hours or daily	1	Wheel nuts torque							
	2	Grease zerks/nipples							
	3	Engine oil level							
	4	Engine coolant level							
	5	Hydraulic/hydrostatic oil level							
	6	Drive belts and chains tension							
	7	Cab air filter							
	8	Fuel prefilter/water separator							
	9	Fuel level							
	10	Stone trap							
	11	Hitch							
	12	Drive Chain							
After the first 50 hours	13	Final drive Oil level							
	14	Traction gearbox oil level							

SERVICE INTERVAL	OPERATION Nº	MAINTENANCE OPERATION	CHECK	CLEANING	GREASE	LUBRICATION	REPLACEMENT	ADJUST	DRAIN
Every 50 hours	15	50 hours grease zerks/nipples			●				
	16	Wheel nuts torque	●					●	
	17	Tire pressure	●					●	
	18	Rotary dust screen and cooling system		●					
	19	Air conditioning evaporator		●					
	20	Air reservoir (if installed)							●
	21	Drum concave opening	●						
	22	Brake fluid level	●						
After the first 100 hours	23	Hydraulic/hydrostatic Oil filter					●		
	24	Traction gearbox oil					●		
	25	Final drive oil					●		
Every 100 hours	26	100 hours grease zerks/nipples			●		●		
	27	Cab air recirculation filter							
	28	Engine oil and filter (if biodiesel 830 or higher is used)							
	29	Steering ball joints, wheel spindles, tie rods and steering hydraulic components	●						
	30	Pivot points				●			
	31	Threaded rods				●			
	32	Fuel filters					●		
	33	Fuel prefilter/water separator					●		
	34	Brakes		●					
	35	Parking Brake	●						
Every 600 hours	36	Engine air filter main element					●		
	37	Engine oil and filter					●		
	38	Final drive oil					●		
	39	Traction gearbox oil					●		
	40	Cab air filter				●			
	41	Cab air recirculation filter				●			
	42	Hydraulic/hydrostatic oil and oil filter				●			
	43	DEF/AdBlue® in-line filter (if SCR engine)				●			
	44	DEF/AdBlue® supply module filter (if SCR engine)				●			
Every 1200 hours or 2 years	45	Engine coolant					●		
	46	Brake fluid					●		
	47	Engine air filter safety element					●		
Every 3000 hours	48	Cleaning shoe silent blocks					●		
Every 4500 hours	49	Hydraulic and hydrostatic hoses					●		
As required	50	Alternator		●					
		Moisture sensor (if installed)		●					
		Hitch (if installed)		●					

Source, Buyers' Guide for Agricultural Machinery in Ethiopia, GIZ

Table 11. Routine Maintenance Schidule

3.13 PLANNING MACHINERY SERVICES

3.13.1 WORKING CALENDAR

Table 12. Work calendar

CROPS	MAIZE				
Operation	**Method**	**Time**	**Work rate**	**Seasonal demand**	**Tractor-days demanded**
Planting/ripping	Double row	Mid-July- mid-Oct	1.2 ha/day	25 ha	21
Shelling	2WT-driven sheller		3 tonnes/day	34 tonnes	11
Water lifting	Axial pump		3 ha/day	4 ha	1
Transport	1-tonne trailer	Jan-Dec	4 km/day	40 tonne-km	10

Source FAO and CIMMYT, 2018

Table 6 a tractor-use plan for 2WT operations in a maize-growing area in sub-Saharan Africa. The 2WT operations include ripping/planting as a bundled operation. The machine can also be used for shelling maize, irrigation (water pumping) and transportation. Table 5.3.1a indicates the method, timing and the output, seasonal demand and time required for each operation. Specifically:

Work rate (output) is based on the service provider's estimate of what can be achieved.

"Seasonal demand" is based on the number of customers requesting the service and the area/volume of demand for the operation (area of land, distance transported, volume of produce to be processed).

Tractor-days demanded are obtained by dividing the seasonal demand by the work rate.

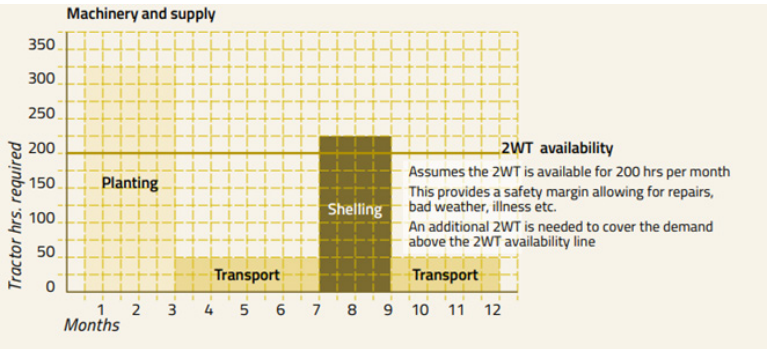
Compare the tractor-days demanded with the tractor days available in a given period.

To calculate the available time, multiply the number of days available by the average number of hours of operation per day Include downtime by taking into account the estimated time that the machine is not in use due to travelling to the customer's plot, breaks for operators for meals and rests, and breakdown In provision is made for 6 working-days a week (48 hours per tractor-week) and for 4 weeks a month

In practice, demand may exceed time available; in this case, it may be necessary to work 7 days a week (instead of 6) and/or double shifts to complete the operation.

At times of the year when there is no seasonal demand, it is important to allow the machinery to be used for off-farm operations, such as transportation.

Figure 5.2 Schedule of demand and supply of tractor services



CHECKLIST OF HOW TO PREPARE A SCHEDULE		
1	Establish target dates for preparing the soil, planting, harvesting, and shelling/threshing and time available for transportation and other income-earning work.	
2	Establish the sequence of operations for each crop.	
3	Estimate the number of days available for the different operations and the actual time each of the operations is likely to take.	
4	Estimate the number Of people needed to operate and assist in the tasks.	

Note that the following items should be determined for operational scheduling:

1. Number of active tractors
2. Estimated number of hours the tractors are working per day.
3. Estimated average performance capacity of the tractors for all tillage types per hour.
4. Estimated number of days the tractors are working in all tillage activities.
5. Estimated number of effective days of the tractors are working for tillage per year.
6. Total number of planting days (for both maize and wheat)
7. Total number of estimated service days for fertilizer application
8. Total of number of days for crop protection
9. Total number of days for wheat combine harvesting services.
10. Total of number of days for maize combine harvesting services.
11. Total Number of days for maize shelling services
12. Sheller capacity per hour (Qt/hr.) (PTO driven)
13. Combine harvester capacity (qt/per hour) for wheat.
14. Combine harvester capacity (Qtl. /hour) for maize
15. Estimated number of days for lime/compost spreading
16. Estimated number of lands covered with compost/lime.
17. Estimated number of farmers using transport services
18. Average number of farmers served per day for transport services.
19. Average number of farmers served per day for lime/compost spreading services.

3.13.2 SCHEDULING OPERATIONS

Scheduling allows the manager to:

- Plan and forecast the needs for the machinery.
- Decide the location and timing in order to optimize use of the resources.
- Allocate the time of use of the machines available.
- Prioritize what services to provide; and
- Decide when to conduct services, who will operate the machinery and what equipment will be needed.

OPERATION	RIPPING SERVICE				
Timing	Mid Jan - mid April				
Crop	Maize				
Machinery requirements	2W-tractor Ripper				
Labour requirements	2				
Customer	Area demand (ha)	No of hours required	Location	Starting date	Completion date
1	2	3	Mohales Hoek	15 Jan	18 Jan
2	3	4	Mafeking	19 Jan	22 Jan
3	3	4	Manzini	26 Jan	30 Jan
4	4	4			
5	2	3			
Estimated total time					

Schedules may be on a monthly, seasonal or longer-term basis, but they are usually prepared for the short term. It is necessary to draw up a timing schedule of what is needed, when, where and for how long.

	SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	OPERATOR REPONSIBLE
Customer 1								
Customer 2								
Customer 3								

3.13.3 DISPATCHING OPERATIONS

Good management requires planning well ahead of time. Nevertheless, uncertainties are inevitable. Reality does not always respect plans, unexpected things happen. While planning is very useful, hire service managers still need a system for deciding the tasks to be done that week, or even on a particular day. This is called dispatching. For effective dispatching of operations, the manager must rapidly assess which jobs take priority. Establish simple rules to prioritize operations, based on, for example:

- **First come first served:** Prioritize the customer who orders a service first. This commonly applied rule is generally regarded as fair.
- **Shortest time to complete the operation:** Start first the task with the shortest operating time.
- **Shortest distance to customer:** Provide services to the nearest customers first. This reduces the costs of transportation.
- **Field size:** Prioritize field operations for customers with largest plots. This reduces turn-around time and increases revenue.
- **Earliest due date:** Start first the operation that needs to be completed as soon as possible. Operations that are not vital can be postponed.
- **Earliest start date:** Start first the operation that needs to commence the soonest.
- **Random selection of tasks:** Start whatever job happens to come up.
- **Economic importance:** Prioritize operations with the best economic returns.
- **Social network/family connection:** Prioritize customers according to relationships. Family and social obligations often outweigh business interests.

Post assessment question

1. *Show how to estimate power requirement of a machine.*
2. *List and discuss the different cost components of machinery use.*
3. *Discuss timelines cost and breakeven point calculations.*

Take away message

Understanding technical and financial aspects of machinery selection and managing the different cost components are vital for establishment of successful hiring service business.

BUSINESS RISKS AND MITIGATION MEASURES

NO	POTENTIAL RISKS	MITIGATION MEASURES
1	Technical nature of machinery management may pose difficulty to understand for trainees	Preparation of module in local language simplifying terms and procedures
2	Adverse effects of climate change and consequential variations in rainfall (weather) pattern may shorten timing of machinery operations.	Modernize mechanization services using digital platforms, introducing responsive agriculture, diversify operations
3	Low productivity and small land holding of small-scale farming affect the need for hire services.	Services to focus on Farmers' production clusters, land consolidated areas, serving farmers' groups, seed multipliers, etc.
4	Absence or lack of credit scheme suitable for Mechanization SP	Government should consider special needs of MSP and arrange for credit
5	Availability of high-quality machinery at reduced price	
6	Lack of foreign currency for purchase of machinery	Special Government attention to support SP. A favorable tax/duty/ excise structure should be developed for this sector
7	Availability of qualified operator	Skills development in agriculture should be promoted. MSCs to be equipped to give training for machine operator

SOURCES FOR FURTHER READING/REFERENCE MATERIALS

- Agricultural Mechanization Strategies, and Agricultural Mechanization Policies for Eastern and Southern Africa countries
- BUYERS' GUIDE FOR AGRICULTURAL MACHINERY IN ETHIOPIA; Implemented by GIZ
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- Food and Agriculture Organization of the United Nations and International Maize and Wheat Improvement Center Rome, 2018
- Segun R. Bello, 2008; Farm Machinery Repair and Maintenance; Fasmen Communications, 79/94 Owerri Road, Okigwe, Imo State – Nigeria.

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