GIZ NuSePPP, Agrimech Africa Ltd & County Government of Nyandarua

Mechanization Service Providers (MSPs) Training Report

Class 1: Tuesday 9th July – Friday 12th July and
Class 2: Tuesday 16th July – Friday 19th July, 2019
Tabor Hill – Nyandarua

Prepared by:

Agrimech Africa Ltd

Total Solutions for Farmers

Abbreviations

GIZ	German Development Corporation
AAL	Agrimech Africa Limited
MSPs	Mechanization Service Providers
AMS	Agricultural Machinery Services
OM	Operator Manual
ACEA	Association des Constructeurs Europeens dÁutomobiles
API	American Petroleum Institute
GL	Gear Lube
PTO	Power Take Off

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1. Background information

Agriculture is the engine of economic growth in **Kenya**. About 75 percent of **Kenyans** earn all or part of their income from the sector. However production levels remain way below the possible potential. The low agricultural productivity has been associated with numerous factors, one of them being low levels of mechanization.

Mechanization, which is the application of machines, implements and equipment in various farm activities is therefore a crucial input for agricultural value chains from land preparation to harvest and postharvest handling. Historically mechanization has been neglected in Kenya. More emphasis has been on other production aspects like quality seed and use of fertilizers among other agronomic practices. There is now renewed interest in mechanization in Kenya and across African countries. This effort is however likely to be curtailed by lack of workable business models as much as lack of skilled Mechanization Service Providers (MSPs). Most of the MSPs engaged in farm operations will typically have learned on the job, as tractor "Drivers" but not "Operators". They will have used basic tractors, mostly pulling ploughs and remained unaware of equipment for other operations like for crop care, harvest and post-harvest operations. Such MSPs operate in uncoordinated manner, travelling long distances and doing rushed operations in a race to make a quick shilling. They will often leave behind damaged lands and many unsatisfied customers. This impacts negatively on operational capacity and efficiency and leads to nowhere near the anticipated increased crop productivity, mechanization is expected to bring about.

2. Why training of Mechanization Service Providers is important

The tractor and its attachments form the backbone of the mechanization business. It is therefore critically important that they are properly power-matched, used effectively and efficiently and kept properly maintained on a regular basis. Proper machinery use and care will maximize the work-days and the lifespan of the machinery by reducing the chances of breakdowns that can result in costly downtime.

Most MSPs have limited skills and exposure to tractorization, not to mention the advancing, modern machines and equipment of this day. They lack awareness of machinery beyond the plough. They lack correct knowledge in vital equipment adjustments, calibration for optimal operations and applications and safe use of the equipment. New farming methods have since come into play, necessitating retraining even those that have been deeply involved in their operational trade. Apart from operational performance of machinery and equipment, most MSPs do not keep records. Records provide vital machine use data, tracking of equipment performance and routine maintenance schedules. Used appropriately records tell the overall performance of the service provision business.

Training is important because it results in fewer mistakes and a better final service product for the farmer. When MSPs are well trained, they ultimately provide more profitable, efficient and safer workplace environment. Good training also increases environmental protection and increased land and crop productivity for the farmer, more so in these days of climate change challenges.

3. Description of the assignment

The objective of the task was to conduct 2 weeks of theory and practical training to tractor operators and service providers through practical field demonstrations on agricultural tractors and equipment for different and representative field operations.

The specific tasks of the assignment were to organize the best team of trainers to:

- Provide theoretical background of tractor and implement use for different crop and livestock mechanization applications.
- Train on the principles and practice of specialized tractor and implement parts like engine and engine parts, batteries, power-train (transmission), hydraulics, tyres and tracks, bearings, PTOs ad knoters, etc.
- Showcase tractor-implement calibration, servicing, routine maintenance and safe-use of machinery.
- Conduct practical field training on planting, chemical application and harvesting of potatoes.
- Showcase new applications of tractors and implements to the service providers.
- Prepare the final report and follow-up recommended actions agreed after the training.

4. Outcomes of the Training:

1. An Agrimech led and GIZ supported team of MSPs is in formation to improve the range and quality of mechanization services available to farmers in the crop and livestock value-chains of Nyandarua County and beyond.
2. An established team and league of qualified, organized and dependable mechanization service providers (MSPs) who are able to serve farmers within their localities for longer periods of time and saving on unnecessary nomadic travel across the country.
3. Available and able MSPs who understand and are able to work in a more formalized and coordinated structure under a software managed platform, technologically tracked and electronically paid for services rendered (Trotro UBER, software)

5. Training approach

The training was conducted by Agrimech Africa Ltd Engineers and Finance professionals, assisted by a visiting trainer Bas Noaktgeboren of PUM of Netherlands and Engineer Kariuki Njunge. GIZ colleagues handled administrative issues of Operator contacts, arrivals, accommodation and associated logistical matters.

The first task of the trainers was to advertise the course, invite trainees and develop an appropriate training curriculum specifically designed for tractor operators. This is presented in the appendices. The attitude adopted was that tractor operators had own experiences to share. In this regard continuous discuss and commentary was encouraged.

The training was organized in two batches each lasting 4 full training days. Each batch had a maximum of 12 trainees. The small size of class allowed intensive interaction, intimate practical interactions and individualized attention.

The training consisted of both theory and practical sessions aided with appropriate training aids such as power points and actual machinery and equipment parts. It was conducted in a conducive and friendly environment encouraging each participant to fully participate.

The Agricultural Machinery Services (AMS) Centre in Nyandarua was deliberately selected to partner in the training as it has the requisite machinery, tools, implements and resource personnel to support the training.

To emphasize the practical and participatory nature of the training, mornings were dedicated to theory and afternoons to on-farm practical experience, to make real what would have been understood in the theory. This gave participants ample time to interact with the selected tractors and implements, make necessary adjustments, calibrate and operate them.

Operators were lightly exposed to business skills and operating machinery, considerate of costs and long-term preservation. A deeper business skills course for tractor owners was preserved to be part of the way forward, following the course. This course was therefore adapted to be primarily for operators.

6. Training activities

This section illustrates in passing, the contents of the curricula with a few diagrams, illustrations and pictorials presented, to form part of what was used in the delivery of key principles and messages in the focus areas of the training program.

The contents were designed to highlight important considerations in operation of farm tractors and associated equipment. The contents provoked discussions and feedback between the trainer and participants. The content was presented in manner that allowed participants to share their own knowledge, experiences and also express their opinions in the subject matter. The material was presented in a logical progression starting with the farm tractor in Day 1 and continuing to land preparation, planting and spraying, etc., in Day 2. Day 3 was dedicated to potato planting equipment as a special area of focus, given the importance of the potato value chain in Nyandarua's activities. Day 4 was dedicated to livestock machinery, operational troubleshooting and safety. Troubleshooting was a topical matter that the operators appeared to enjoy greatly.

The theoretical aspects of all topics were first presented in a classroom setting using power points, short videos, flipchart illustrations and discussions. Practical sessions in the field followed.

Day 1

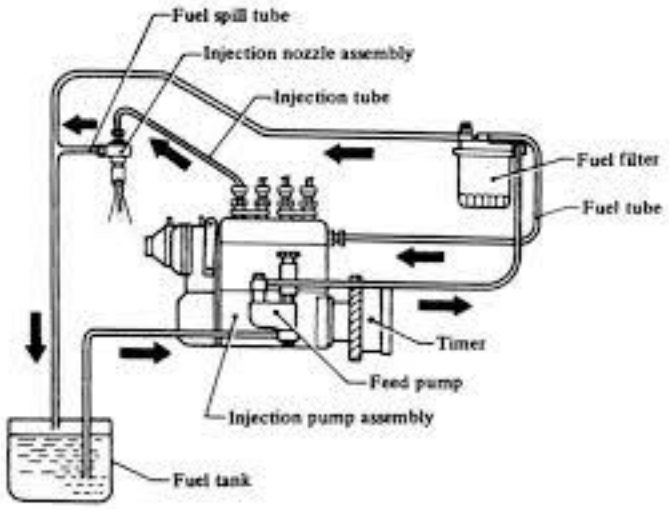
The farm tractor:

Contents and Operator Learning Covered:

The diesel engine and how it works – internal combustion; and the systems, which make the tractor work. Two types of engines were recognized– Naturally aspirated (without turbo) and turbocharged (with turbo) and the difference between the two.

Systems which make the tractor work:-

Diesel fuel system: fuel tank, fuel lift pump, fuel filters, injection pump, and injector nozzles.



- Check the filters regularly. The fuel system is equipped with filters to protect against dirt, water, or other contaminants that could cause failure of the components.
- Check the fuel filter for accumulated water. Most diesel engines have a water-separating filter, since diesel fuel attracts moisture. Therefore, it is important that the fuel supplied to nozzle must be absolutely clean.
- Fuel Filter types are two: The primary and the Secondary Fuel Filter.
- Using clean fuel always can extend the life of your filters to 400 hrs and more.
- How to carry our Filter replacement and the importance of sanitizing the process.
- Importance of keeping the fuel tank full to avoid moisture accumulation.
- The primary function of a diesel engine **intake system** is to supply the air required for combustion. The system also cleans the air and reduces the noise created by the air as it enters the engine. An intake system may include an air silencer, an air cleaner and screen, an air box or header, intake valves or ports, a blower, an air heater, and an air cooler. The diesel engine needs a lot of air to work well. As an indication, a 4-litre displacement engine running at 2000rpm needs 240 litres of air in 1 hour. The same displacement engine, but with turbocharger needs 384 litres.

- Air intake brings almost 99% of total dust and if not removed can end up in the engine and cause serious wear in very short time. Air filters therefore play a very important role in the air intake system.
- There are 2 types of Air Filters and they are maintained differently:
  - Oil bath air filter just as the old Massy Ferguson and Ford
  - Dray air filters with main primary filter and secondary filter

- There are 2 types of pre-cleaners:

Static pre-cleaners (Donaldson) remove 75% of dirt before air reaches the air filter
Pre-cleaners with spinning fan remove 98% of dirt before air reaches the air filter.

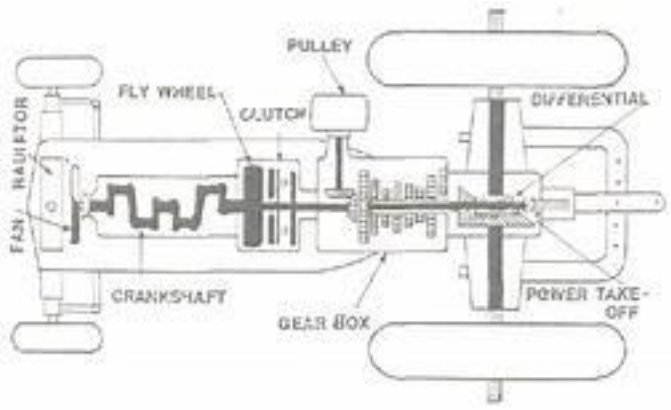
Pre-cleaners save a lot of air filter cleaning and wear on the engine. It's a small investment that saves a lot money.

- The primary function of an exhaust system is to carry gases away from the cylinders of the engine. An exhaust system may be designed to perform one or more of the following functions: muffle exhaust noise, quench sparks, remove solid material from exhaust gases, and furnish energy to a turbine-driven supercharger.
- Engine lubrication system: oil pump, crankcase, oil cooler, oil filter, pressure regulating valve, pressure gauge.
- The Lubricating Oil performs four main functions in an engine. It lubricates, seals, cleans and cools.
- Always fill the engine with the right recommended oil. Oil labelling and numbering has technical meaning and indicators of quality.
- Engines are different. Always read the owner's manual, to know what is recommended for the specific engine.

- Engine cooling system is everything for farm tractors because they work hard. Important parts of a cooling system are such as radiator quality and cleanliness, pressure cap, fan belt, water-pump and thermostat.
- Reasons for cooling problems include low fan speed and airflow in the radiator being limited by dust and dirt.
- Electric system on a tractor is composed of battery, starter motor and alternator. All of these must be in good condition for trouble-free operation.
- The Generator supplies electricity when drive mechanically by the engine. It supplies current to the battery to keep it charged and to power loads connected to it.

- The Voltage regulator has a battery, generator, and field terminal. The operation or rate of charge is controlled by the cutout relay. The cutout is a magnetically operated switch that controls the flow or current.
- The Cranking Motor converts electrical energy from the battery into mechanical energy, which is used to crank the tractor engine for starting.
- The Transmission System has the engine, clutch, gearbox, brakes, PTO implement hitch system and tyres.

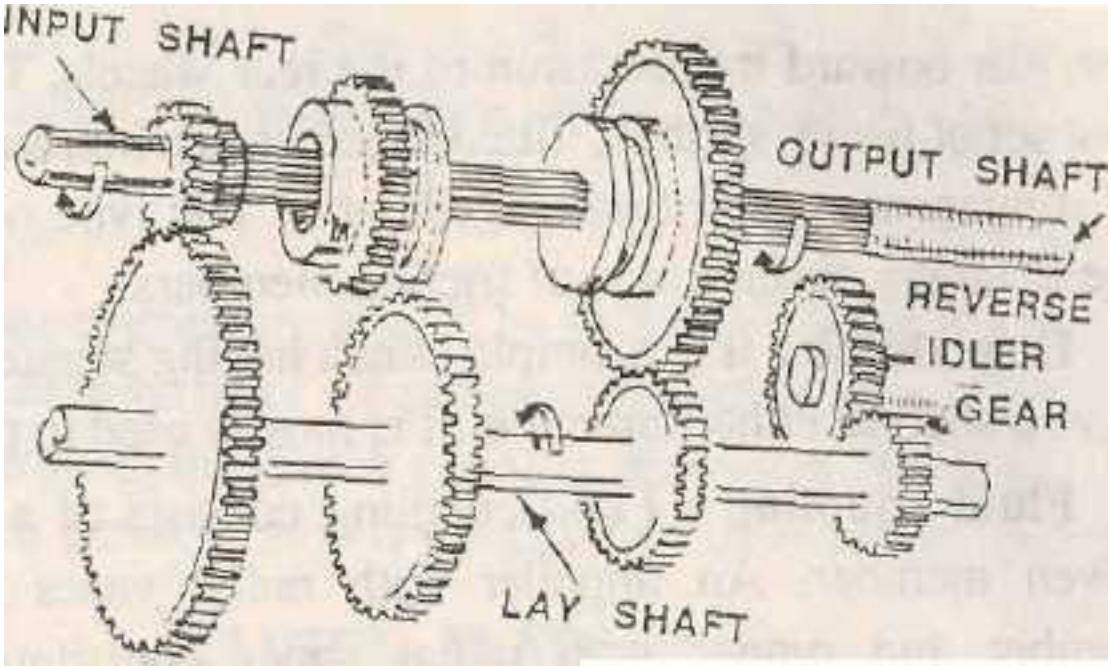
Transmission is a speed reducing mechanism, equipped with several gears. It may be called a sequence of gears and shafts, through which the engine power is transmitted to the tractor wheels. The system consists of various devices that cause forward and backward movement of tractor to suit different field condition. The complete path of power from the engine to the wheels is called power train.



- Transmission variations include:
  1. Standard transmission with and without synchronized shifting
  2. Transmission with power shift
  3. Transmission with internal wet brakes in oil
  4. Transmission with dry brakes outside the transmission

- Transmission oil is different from hydraulic oil. Hydraulic oil is special for hydraulic systems and can handle light loaded gearwheels. To avoid problems which may arise from using all kinds of different oils for transmission and hydraulic systems, you can use Universal oil, UTTO. UTTO stands for Universal Tractor Transmission Oil and is universal for all tractor transmissions and hydraulic systems.
- The Brake system is used to stop or slow down the motion of a tractor. It is mounted on the driving axle and operated by two independent pedals. Each pedal can be operated independently to assist the turning of tractor during the fieldwork or locked together by means of a lock.
- The Clutch is to connect and disconnect the engine and the gearbox and allows the changing of the gears.

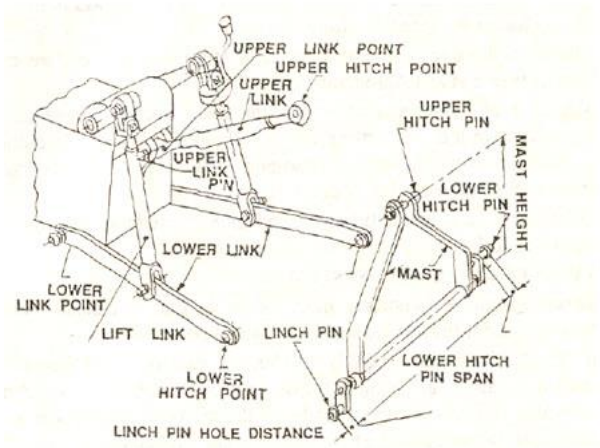
- The tractor engine runs at high speed, but the rear wheel of the tractor requires power at low speed and high torque. As the tractor has to transmit heavy torque all the time,-best quality lubricants free from sediments, grit, alkali and moisture must be used for lubrication purpose.



- The Power Take-Off (PTO) is a part of the tractor transmission system, used to transfer power to external implements running at 540 or 1000 revolutions per minute.
- The Implement Hitch mechanism attaches the implement to the tractor so that the orientation of the implement is fixed with respect to the tractor and the arm position of the hitch. The tractor carries some or all of the weight of the implement.

The three-point hitch is made up of several components working together. These include the tractor's hydraulic system, attaching points, the lifting arms, and stabilizers.

There are five different hitch sizes, called categories. The higher category hitches have sturdier lift arms and larger connector pins.



Three point hitch with hydraulic lift

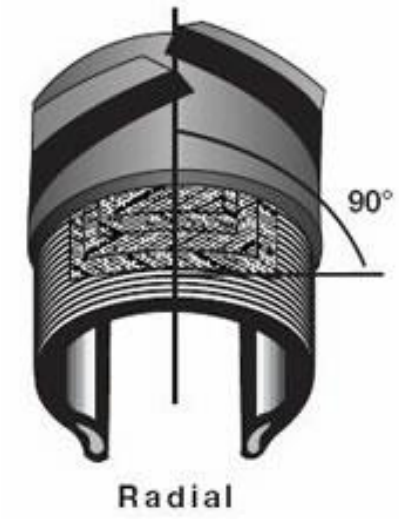
Category	Tractor power	Top link pin diameter*	Lift arm pin diameter	Lower hitch spacing
0	Up to 20 hp (15 kW)	5/8 in (16 mm)	5/8 in (16 mm)	20 in (510 mm)
1	20 to 45 hp (15 to 34 kW)	3/4 in (19 mm)	7/8 in (22 mm)	28 in (710 mm)
2	40 to 100 hp (30 to 75 kW)	1 in (25 mm)	1 1/8 in (29 mm)	34 in (860 mm)
3	80 to 225 hp (60 to 168 kW)	1 1/4 in (32 mm)	1 7/16 in (37 mm)	40 in (1,000 mm)
4	More than 180 hp (130 kW)	1 3/4 in (44 mm)	2 in (51 mm)	48 in (1,200 mm)

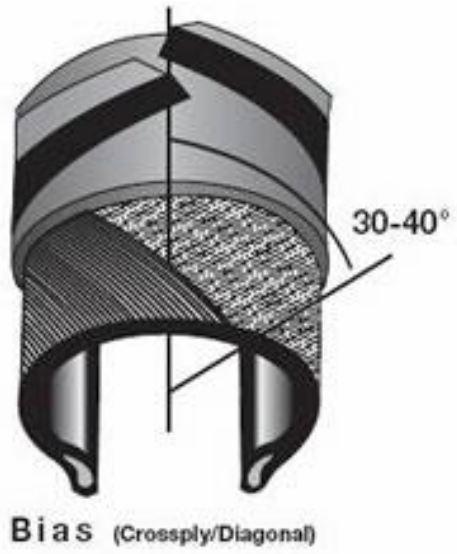
* refers to implement end; tractor end not specified

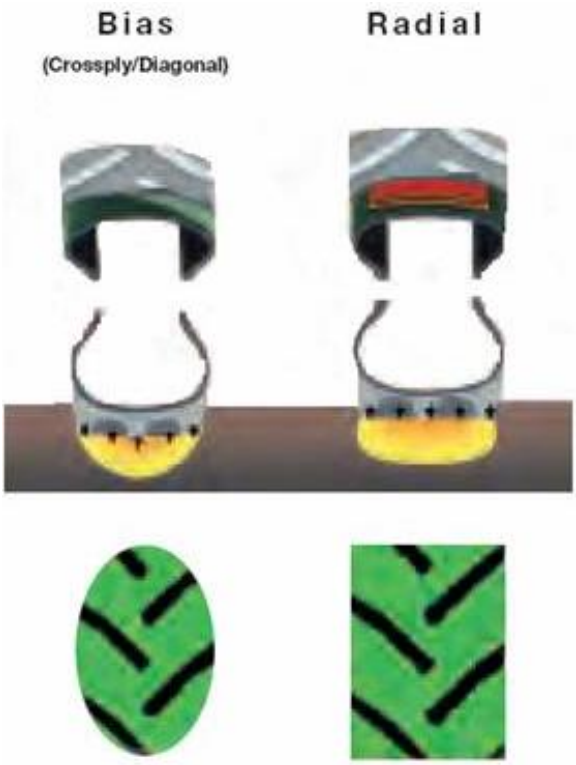
- Single-point hitch - The other main mechanism for attaching a load is through a drawbar, a single point, pivoting attachment where the implement or trailer is not in a fixed position with respect to the tractor.

- Tyres: Tyre sizing and ply-rating, radial versus Bias-ply tryres, operation pressure, ballasting with weights and with water.

Bias Ply vs. Radial







Bias (Crossply/Diagonal)	Radial
CONSTRUCTION	
Simple	Sophisticated
Easy to repair	
FOOTPRINT	
Round shape	Square shape
Uneven pressure distribution	Even distribution
High soil compaction	Less soil penetration
PERFORMANCE	
Flexible	Superior traction
Forgiving	Good stability
	Puncture resistant
	Low rolling resistance
	High mileage
	Good comfort
	Durable
	Even wear

Day 2

Equipment for land preparation and planting

Content and Operator Learning Covered:

- Aspects of good seedbed preparation – primary tillage, secondary tillage, reduced tillage, soil health, soil structure and compaction.

- *The Chisel Plough* – types, main purpose and advantages over other ploughs, design and construction – the frame, shank and tines, shank/tine profiles and effect on power requirement, adjustments for levelness and depth, operating speed and the right time for their application.
- *The Diesel Plough* – types, main purpose and advantages over other ploughs, design and construction – the beam or frame, hitch bolt, disc scraper, disc hub, rear furrow wheel, lift crank & miscellaneous parts required to connect the frame discs, hubs & gauge wheel – cast spools, end washers, axle nut locks, spacer tubes & slack wheel. Adjustments for level, depth, operating speed, soil-type maintenance and safety.

- *The Harrow* - common types and variations – disc harrow, chain harrow, tine harrow or spike harrow, spring tine harrow; main purpose and, design and construction – the frame, 3-point mounted, hydraulically operated by wheels, hitch bolt, disc scraper, disc hub & miscellaneous parts required to connect the frame discs, hubs – cast spools, end washers, axle nut locks, spacer tubes. Adjustments, operating speed and the right time for their application. Maintenance & safety.

Planters:

- *Maize planter* – different types of maize planters, metering for seed and fertilizer delivery systems and their advantages over each other, seed and fertilizer placement and depth adjustment, calibration and maintenance.

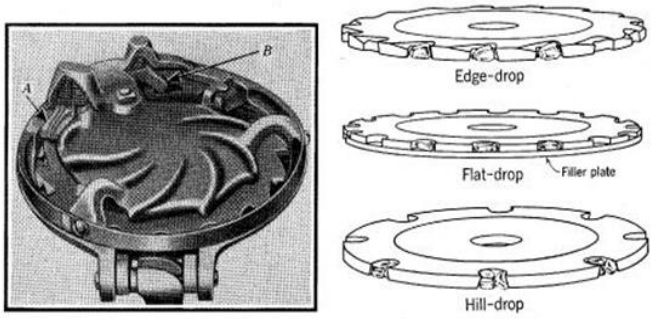


Fig. 11.4. *Left:* Hopper bottom for typical horizontal-plate corn planter. Note the spring-loaded (yielding) cutoff *A*, and the spring-loaded knockout pawl *B*. *Right:* Three types of edge-cell plates used interchangeably in this hopper bottom. (International Harvester Co.)

Maize Planter and Seed Metering Device

- *Air seeder* – different types, metering for seed and fertilizer delivery systems, seed and fertilizer placement and depth adjustment, calibration and maintenance.

Trainees learnt the following aspects of planters:

- Cut-off mechanism for seeds.
- Knock out mechanism for seeds
- Planter drive transmission system
- Furrow openers
- Settings for spacing of seeds or hills inside and between rows.
- Covering device or furrow closer
- Drive transmission system
- Furrow openers
- Planter calibration
- Planter maintenance checklist

Day 3

Potato planting and spraying equipment:

Content and Operator Learning Covered:


- *Seedbed preparation for potato*– Chiseling (preferred over ploughing), harrowing (not necessary after Chisel-Crumbling) and bed-ridging.
  Operators were trained the conservation (Climate-Smart) agriculture approach to potato farming. They learnt that potato seed require a well-prepared seedbed with adequate volumes of loose soil to give the seed space to grow and enough room for the tubers to multiply. This can be achieved through deep ploughing or chiseling (20-30cm) followed by harrowing to break up clods (lumps of soil) and to provide a finer finish, a good tilth or soil structure that is suitable for seedbed use. The field can then be ridged ready for planting. Care should taken not to make the soil too fine. The best time to carry these operations is when the soil is dry.

- *Planting and weeding* – Planting can be done on the flat and ridges formed in another operation using a non-powered ridger or rotary tiller with facility for making ridges.

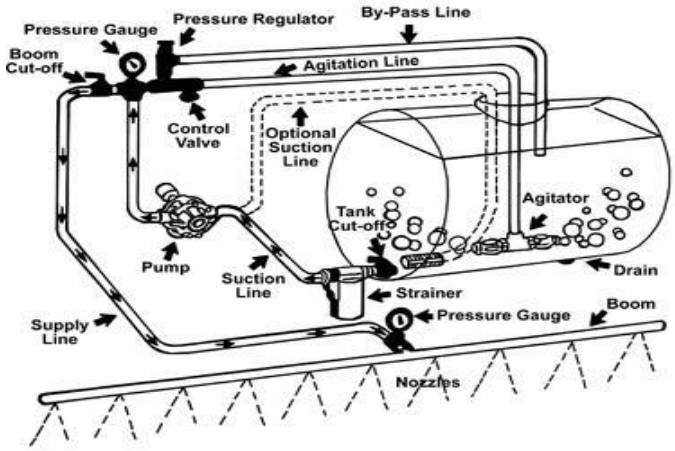
The ridges can be made first and the seed placed on the ridge using a planter. Planting depth should be between 12-15cm. When the seed has germinated and leaves are showing above the ground, hilling is carried out to heap more soil around the seedling and to get rid of emerging weeds. Additional hilling may follow later for weed control.

- *Potato Planter Management and Calibration* - Proper calibration of the potato planter is essential to obtain uniform plant stands. Operators learnt that a planter that is properly adjusted, maintained and operated will ensure accurate placement of seed. They were trained to understand the concept of pre-delivery setup, and how to read the operator chart attached to the planter.

  They were trained to inspect planter hook-up and leveling, noting ballast may be required to reduce tractor wheel slippage. They learnt to inspect potato cup sizes, the picker arm for rivet wear. Also to be checked are cup inserts, chain linkage wear and wear strip condition, agitator for unnecessary chain vibration and seed chutes for obstructions.

- *Harvesting* - Harvesting is done when the potatoes have matured enough and the tops of the vines have died.

- *Spraying* – Is carried out to control diseases, pests and weeds to maintain crop quality and increase yields. Operators familiarized themselves with sprayer parts: spray tank, pump, and pressure control valves, nozzles, sprayer calibration, safe use of chemicals (purchasing, transporting, mixing, application, cleaning equipment, storage & disposal), sprayer maintenance.



Boom-Sprayer

Operators learnt that sprayer calibration is key to application of the right amount of chemicals prescribed for the specific treatment. The correct pressure, boom or nozzle height and forward speed must be maintained to deliver the desired amount of

chemicals. The sprayer must be calibrated every time a new application is being made.

Day 4

Hay making and Silage Processing:

Content and Operator Learning Covered:

- *Haymaking* – Involves a multiple step process: cutting, drying or "curing", raking, baling and storing. The leaf and seed material in the hay determines its quality, because they contain more of the nutrition value for the animal than the stems do.

  Good practice is to harvest hay at the point when the seed heads are not ripe and the leaf is at its maximum. The cut material is allowed to dry so that the bulk of the moisture is removed but the leafy material is still robust enough to be picked up from the ground by machinery and processed into storage in bales, stacks or pits. Methods of haymaking thus aim to minimize the shattering and falling away of the leaves during handling.

Special equipment for haymaking includes the disk mower, drum mower, rake and the baler.

The disk mowers - The disc mower is used cut or mow the grass just above the ground. Cutting blades mounted on disks that run towards each other at 540rpm PTO speed achieve cutting. If a blade hits a hard object the blade will retract, and open out again.

Among many details, Operators learnt that the mower is fitted with overrunning clutch to protect the tractor driveline. The blades on the mower should be renewed at the same time and not one at a time.

Drum mower - The disk and drum mowers are very similar. The difference is the blades on the drum mower are attached firmly to a drum. They don't have any freedom to move. They are suited for different applications. A drum mower will do a better finish on greens, lawns. As long as they have a smooth surface, and are clean. The disc mowers are usually used for rougher grass areas, with an uneven surface.

Silage making – Silage is made by packing chopped crop into a "pit" and packing it down well so that any oxygen pockets are eliminated. Oxygen pockets encourage spoilage of the feed.

Daily Checks, Troubleshooting and Safety

Content and Operator Learning Covered:

Tractors are essential to many daily tasks on the farm. Although we use tractors frequently, it's important to keep the tractor in good working condition and not to push the boundaries when it comes to operating or repairing the tractor. This will avoid unnecessary downtime and prolong the life of the tractor, saving you costs.

Guided by your operator's manual, set up a daily maintenance routine to check:

- Engine oil and hydraulic fluid levels
- Radiator coolant level
- Brakes and brake fluid
- Tyre pressure
- Fan belts

Check to ensure implements are secure and properly connected. Check carefully for hydraulic leaks by using a piece of cardboard or wood rather than your hands. Grease all necessary points as guided by the user manual.

Operators were exposed to the Guide below, complete with details to help diagnose the cause of problems when they occur. Lengthy trouble-shooting solutions to the troubles were covered and will be eventually placed in a Trainees manual:

Trouble
• Engine will not start • While starting, the engine will not turn • While starting, the engine is turning but will not run • Engine with CAV rotor fuel injector pump
• Engine overheats easily and water comes out of the radiator
• Water disappearing from the radiator without visible leaking
• Engine is running after starting but emits white/gray smoke
• Engine has less power
• Oil level goes down
• Oil level goes up
• To keep engine performance at it peak
• Listen to the inside of the engine

Safety in the use tractors

This topic was also of great interest to the trainees. Some of the lessons that came through to them were such as:

- Follow manufacturer's and operator's manual instructions
- Keep all guards in place and avoid loose clothing that could catch in moving parts.
- Never attempt maintenance adjustments on the tractor with the engine running. Rotating parts like V-belts and pulleys are particular danger points.
- Keep on-lookers and other curious persons (especially children) at a safe distance to avoid injury from flying debris.
- Take extra care on sloping ground. Use a low gear and low speed. Always keep the transmission in gear and don't attempt gear changing on the move.
- Keep well clear of a hot exhaust pipe or radiator.
- Make sure that the gear lever is in its neutral position before cranking the engine.
- Never attempt sudden turns with the steering clutches at high forward speed, slow down first.
- Avoiding driving on steep hillsides
- Backing the tractor up steep hills

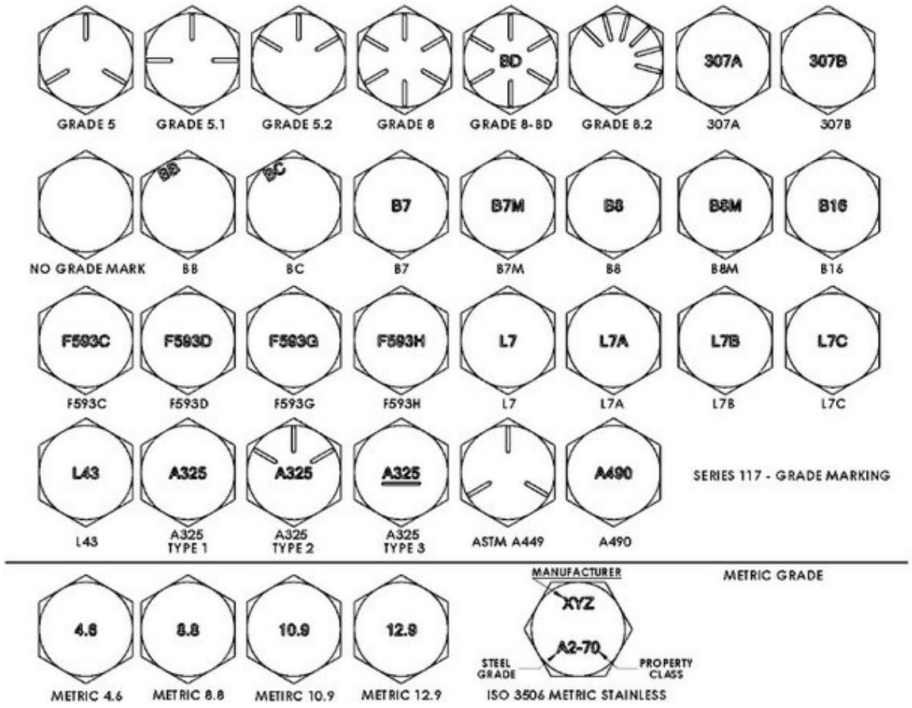
- Avoiding driving too close to the edge of roadside ditches or slopes
- Use tractors equipped with a Roll-Over Protection Structure (ROPS)
- Wear appropriate attire. Loose-fitting clothing is easily caught in the moving parts of tractors and other equipment. Wear fitted pants, tuck in any loose shirttails, and avoid wearing scarves when working on or around machinery. Protect your feet by wearing sturdy work shoes or boots with non-skid soles and steel toecaps. Heavy work gloves and safety glasses are also be useful when working with machinery.
- Mount and dismount tractor safely. Many tractor-related injuries occur as a result of falling while mounting or dismounting the steps of the tractor. The steps on the tractor should be used like the steps of a ladder; either two hands and one foot or one hand and two feet should be in contact at all times. Be sure your pant cuffs or boot loops are clear of the pedals when you exit the tractor to prevent tripping or falling.
- Do not carry extra riders on heavy machinery, unless it is equipped with a buddy seat. To keep all riders safe, there should only be as many passengers on the tractor as there are seat belts. Accidents can happen, even from cabs with locked doors.
- Avoid starting a tractor or equipment while standing outside the cab or on the ground. An operator who starts a tractor while standing on the ground cannot be sure if the transmission is in neutral or park. If your tractor does not have a shield covering the starter motor, retrofit shields are available to prevent by-pass starting.

Bolts and nuts

All machines are built up with bolts and nuts. Operators learnt that while bolts and nuts may look the same, they are different in steel quality. They learnt that it is very important to use the right quality of bolts and nuts as specified for the specific application. Bolts of lower quality will untighten and break easily.

The quality of the bolt and nut is indicated by a mark on the head of the bolt. Common quality is 8.8 for European Standard or Grade 5 for American Standard.

European standard	American standard	Comment
4.6	No marks	Bad quality. Don't use
8.8	Grade 5. Has 3 marks on the head Grade 7. Has 5 marks on the head	Most common quality 10% stronger than 8.8
10.8	Grade 8. Has 5 lines on the head with small opening on the centre	



Bolt grade marking

Tightening of Bolts and Nuts:

Operators learnt that to tighten bolts a Torque Wrench is required, a practice that can be said to completely absent among Operators and their mechanics.

Bearings and seals:

Operators learnt that non-sealed bearing such as roller bearings must be filled with grease when being replaced or after they have been cleaned. They were shown how to make sure they fill them completely to avoid premature failure, among many details they had taken for granted.

7. Key findings

Participants profiling at the beginning of the training and subsequent interactions showed a big gap between actual practice and the prescribed way of doing things the right way. Obviously this results in misuse of machinery and equipment resulting in poor

operation, high tear and wear of machinery, high downtime and resultant high cost of machinery ownership and loss of profits. Some key bad-practices and knowledge gaps were identified as seen from the shocks operators received after learning some things they have done wrong for a long time. As a few examples of this, and from operator reports:

- There is huge difference between quality and lousy items operators will purchase for daily use. Some of the most likely to cause poor performance and even serious injuries around agricultural machinery are bolts and nuts, bearings and welding rods. Operators considered it greatest of learnings to realize there are classes of these items and even quality markers on them.
- Batteries that are supposed to last 3 to 4 years last for periods as low as 6 months for them. This is because of poor battery sitting (on the tractor body), servicing, poorly connected terminals that are exposed to knocks as terminals are forced in place, among other aspects.
- Well maintained engines will work for 20 to 15 years, not the 5 years most operators associate with their tractors. Dust and dirty diesel are the greatest culprits in shortening the life of tractors.
- Tyres are over-inflated and cause great compaction on farmers' fields. This drastically interferes with potential yields and operators should be held responsible.
- Chisel ploughing and minimum soil disturbance are good for soil health and productivity performance. A paradigm shift is needed between good land preparation as in Conservation Farming and soil destruction, chasing what operators called clean fields, where no trash is seen on the farm.
- Tractor hydraulic systems are often worn down by operators who, if they knew what they were doing, would find that poor hydraulic function may often result from a worn-out rubber ring costing 500/-.

Hundreds of other revelations came to tear down the experience of operators, some of whom have repeated bad and detrimental practices over periods of a decade and more.

This training was very timely and more of its kind need to be conducted frequently to equip more operators with knowledge and skills required for professional use of machinery. There is very large number of unskilled operators out there and until their knowledge and skills are upgraded through training, field operations will remain poor and machinery and equipment usage and life will continue to be limited, if not detrimental. The overall outcome of unskilled or unaware operators is an overall and negative impact on agricultural productivity and profitability. If agricultural mechanization is to succeed, training of operators is essential.

8. Participant's feedback

Participants expressed satisfaction with the way the training was conducted, the content and choice of the venue. They said the content was relevant to their day-to-day operations and was presented in a detailed manner both during theory and the practical sessions. The use of visuals, illustrations and actual machinery and equipment helped a great deal to deliver the course content.

The operators were particularly impressed by the quality of the trainers and facilitators and the entire coordination of the program. However some of the participants felt the time was rather short, whereby a few of the topics were hurried as a result.

They promised to apply the knowledge and skills gained in their operations and asked for follow-ups and refresher courses in the near future.

9. Recommendations

- Lengthen the duration of the trainings.
- Cover more topics in depth for better understanding
- Do on-farm follow-up and refreshers to check if the participants who attended the trainings will follow what they learnt.
- Do trainings more often and reach out to more farmers and operators.
- Organize training for tractor owners focusing on business organization and operationalization.
- Implement a platform on which tractors owned by trained tractor owners can be operationalized.

Key Recommendation:

The course organizers agreed to focus the current training on Tractor Operators. A later and shorter (preferably 2-Days) course is needed soon, for tractor owners, beginning with the bosses of the Operators that were trained, as applicable.

Tractor owners will be trained in making business of Mechanization Service Provision. They will be trained on the benefits of mechanization coordination and team-approach, managed transparently and paid for efficiency and effective services under the Trotro Software. Agrimech has plans to establish equipment banks at hubs where MSPs will be able to train for and access more and modern equipment, to serve their clients even better.

Appendices

Appendix 1: Training schedule

GIZ NuSePPP, Agrimech Africa Ltd & County Government of Nyandarua
Mechanization Service Providers (MSPs) Training Programme
Class 1: Tuesday 9th July – Friday 12th July and
Class 2: Tuesday 16th July – Friday 19th July, 2019

	8.30 – 10.30	10.30-10.45	10.45 – 13.00	13.00-14.00	14.00-15.45	15.45-16.00	16.00-17.00
Day 1:	Welcome Introductions **Introduction to the training programme.** Mechanization Service Provision as a business Introduction to Conservation Agriculture and practice	Break	**Agricultural tractors**: - Introduction to different types of agricultural tractors & their uses. - Different parts of a tractor and their functions - Adjustment of the different parts	Lunch	**Selecting appropriate machinery:** - Technical and financial considerations for selection of appropriate equipment	Break	**Selecting appropriate machinery:** *Technical and financial aspects*: - The purchase Process
Day 2:	**Operating the tractor:** - Manoeuvring and safety considerations - Troubleshooting and routine/preventive maintenance **Machinery & equipment for different field operations:** - Adjustments, calibration & operation - Routine maintenance & care - Safety considerations *Theory & practice*	Break	**Machinery & equipment for different field operations cont…** - Adjustments, calibration & operation - Routine maintenance & care - Safety considerations *Theory & practice*	Lunch	**Introduction to potato equipment:** - Different parts of a potato equipment and their functions - Adjustments of different parts & calibration *Theory & practice*	Break	**Recap and Field Work Preparation**
Day 3:	**Field work** Land Preparation and Climate-Smart Planting, Crop Maintenance & Chemical Application	Break	**Field work** Focus on Potato Mechanization: Chisel/Bedding, Planting, Hiller-Weeding & Harvesting.	Lunch	**Field work** Hay Harvesting & Baling	Break	**Field work** Silage harvesting and chopping
Day 4:	**Managing the hire business** -Coordination &-Assessing the market area -The equipment/input supply chain - Operations -Costing	Break	**Managing the hire business** -Book keeping -Cash flow analysis -Marketing -Accessing finance	Lunch	**Managing the hire business** - Software Platform - Operator tracking.	Break	**Platform Management and Feedback** - Working Together - Feedback & Evaluation

Appendix 2: MSPs Training curriculum

Why training Mechanization Service Providers is important

Most SMPs have limited skills and exposure to modern machines and equipment. They lack correct knowledge in vital equipment adjustments, calibration for optimal operations and applications, and safe use of the equipment. New farming methods have since come into play, necessitating retraining of those involved in their operation. Most MSPs do not keep records, which are vital to tracking equipment performance and routine maintenance schedules as well as the overall performance of the service provision business.

Training is important because it results in fewer mistakes and a better final product. When MSPs are well trained, it ultimately leads to a more profitable, efficient and safe workplace environment, and increased productivity for the farmer.

Why Agrimech is best suited to carry out this training

Agrimech has 20-year experience, knowledge and resources in training and extension services for advancing Conservation Farming and Climate Smart Agriculture from farm to institutional levels. Agrimech is at the forefront of agricultural mechanization efforts taking place in Kenya and beyond.

Expected outputs

- MSPs with better understanding of the usefulness of farm tractor and the ancillary equipment,
- MSPs able to identify the major mechanical parts of the tractor and the ancillary equipment and their functions,
- MSPs able to operate the machines efficiently and safely
- MSPs with better understanding of major failures/breakdowns associated with the tractor and the ancillary equipment and are able to find solutions for how to fix them.
- MSPs with increased knowledge and awareness about running their service provision efficiently, profitably and in a way that is environmentally friendly

Course Curriculum

Aim

The aim of this training is to increase tractor Service Providers' (SPs) awareness and knowledge about the tractor and tractor operated ancillary equipment and improve their skill in operating the tractor and the ancillary equipment safely and efficiently.

Training Objectives

By the end of the training, participants should be able to:

- Understand and explain usefulness of the tractor and the ancillary equipment,
- Identify the major mechanical parts of the tractor and the ancillary equipment and their functions,
- Operate the machines efficiently and safely
- Understand major failures/breakdowns associated with the tractor and the ancillary equipment and find solutions for how to fix them.

Local service providers who already have procured or intend to procure a tractor and associated ancillary equipment for the purpose of providing services to farmers.

Participants

The course is designed for four days of training. The course is designed to include time for instructions, discussions and review, demonstrations and practical exercises. Approximate time for each set of equipment is set in the tables below.

Planning and Preparation

Key consideration for training planning, presentation and organization are given below. The instructor should read each section carefully to ensure effective and efficient implementation of the training.

Course Content and Duration

Participants:	The number of participants should be limited to a maximum of 15. The participants should be divided into groups of 5 for each equipment being discussed. Selection of participants should be based on priority basis among those who already own a tractor or those Intending to purchase one. Participants should preferably have leadership capability, primary level education, and some business experience, and with capability to work outside the household and run a rural business. Participants should be conducted well ahead of the date (at least one

	week) of training to allow them to prepare adequately for the training.
Venue:	The training venue should be selected carefully. There should be a classroom or similar facility having sufficient light, air, electricity, and adequate space for 15-20 participants, and a large bare field/crop land (with adequate space for operating the tractor and selected ancillary attachments exercises) nearby for practical session. The space should be free from outside distractions.
Training aids:	• Multi-media projector and screen for showing videos • Video on "smart tractor and its ancillary attachments" • Pre-prepared Power Point presentations highlighting key messages on all equipment covered in the training. • Flip chart stand, white board, white board pens. • Smart tractor and all ancillary equipment. • A set of appropriate tools for hands-on practical exercises. • Bare field/crop land for practice machine use. • Note books and pens for each participant. • If possible, one successful service provider who is already providing farmer services.
Instructor Competencies:	The instructor should be an experienced field technician and/or extension agent with experience in handling tractors and the entire range of attachments. He/she should have good communication skills, be fluent in the english language
Date of training:	The date of the training should be decided following discussion and agreement with trainees to ensure their participation (preferably during off-season to avoid any financial loss to their business).
Registration:	Participants should reach the training venue on time. Immediate after arrival at the venue, each participant should register their names and then take seat in the classroom. Registration of participants should be completed before beginning of the training session. No registration should be made once training session begins.
Group formation:	Before starting the pre-training evaluation, divide participants into small groups (i.e. 5 participants per group, however, number of groups or number of participants per group may vary depending on total number of participants). Working in smaller groups assures a more action-oriented, hands- on approach to learning. Generally, four to five people should be assigned to work on each available set of equipment. Set up any seating arrangements so these small groups can sit with one another. Participants will take part in discussions, questions and answer sessions, demonstrations, exercises, etc. in this small group throughout all sessions.

Participatory, experiential, and hands-on learning:	Training approach should be participatory, with emphasis on hands-on and experiential learning. The facilitator should utilize techniques that aim to get participants interested and involved in the training, for example question and answer sessions, experience sharing, group exercises, group discussions, group presentations, etc.
Effective and enjoyable training:	The training should be facilitated in such a way that the trainees feel it is useful/valuable (rather than waste of their time). To achieve this goal, the instructor should work to assure that the training is enjoyable (use of fun games, quizzes, sing along, or other techniques to get trainees excited). One-way lecture formats are not acceptable and are discouraged.
Participant evaluation:	A pre-training evaluation test before starting the training session and a post-training evaluation test at the end of all training sessions is mandatory. Pre and post training evaluation questionnaires are attached. In addition, the training instructor should evaluate overall performance of each participant using the 'Participant Evaluation Forms'.
Instructor evaluation:	Participants of the training will evaluate performance of the instructor(s). Training instructor will assist each participants group to fill-up the 'Instructor's Evaluation Form, based on the instructor's presentation style, speaking ability, use of participatory techniques, information provided, and how much they enjoyed the class.

Instructional Content

The intensity of the training may range from an expectation of a basic exposure to the tractor and its multi-use functions to a fully proficient tractor operator. It is important that trainees understand and become comfortable with the tractor controls and with starting, moving and stopping the tractor before expecting them to master complicated maneuvers and the operations of ancillary equipment. Specific instructional details are contained in task sheets identified below.

Tractors

Course content to include different types of agricultural tractors, their uses, operation, preventive maintenance and safe use.

Training Aim

The aim of this training is to increase agricultural machinery service providers' awareness and knowledge about tractors and to improve their skill in operating tractors safely and efficiently.

Training Objectives

By the end of the training, participants will be able to:

- Understand and explain usefulness of tractors,
- Identify the major mechanical parts of tractors and their functions,
- Operate the machine efficiently and safely,
- Understand major failures/breakdowns associated with tractors and find solutions for how to fix them.

Session -1: Introduction to tractors

Learning Objectives:

At the end of the session, participants will be able to:

- Demonstrate awareness of different types of tractors available in the market,
- Understand and state the function and usefulness of tractors as the prime mover of different types of ancillary equipment

Session -2: Different parts of a tractor

Learning Objectives:

At the end of the session, participants will be able to:

- Identify major parts of a tractor
- State their functions

Session -3: Assembly details of a Tractor

Learning Objectives:

At the end of the session, participants should be able to –

- State the functions of different parts of a tractor
- Assemble/adjust the parts correctly
- Operate the tractor safely

Session -4: Operating the tractor

Learning Objectives:

At the end of the session, participants will be able to –

- Check oil, fuel and water levels and add to required levels
- Join the machine with a variety of ancillary attachments
- Start the tractor safely
- Engage gears appropriately
- Drive forward and stop the tractor safely
- Reverse and stop the tractor safely
- Maneuver and turn the tractor with different attachments

Session - 5: Tractor Safety

Learning Objectives:

At the end of the session, participants will be able to:

- State key safety rules/points and observe them
- Pinpoint danger points on the machine and be proactive in avoiding accidents
- Start the machine and operate in the field, and
- Maintain safety of the machine and operate the machine safe

Session -6: Troubleshooting and Maintenance

Learning Objectives:

At the end of the session, participants will be able to -

- Understand and explain common failures/breakdowns of the tractor
- Make basic repairs and adjustments, and solve different operational problems
- Ensure good maintenance of the machine

Tractor Operated Potato Equipment

The course will focus on the entire range of equipment used in potato planting operations. These will include chiseling, rotavating, hilling, ridging, planting and earthing.

Training Aim

The aim of this training is to increase agricultural machinery service providers' awareness and knowledge about tractor-operated potato equipment and to improve their skill in operating them safely, efficiently and profitably.

Training Objectives

By the end of the training, participants will be able to:

- Understand and explain usefulness of potato equipment,
- Identify the major mechanical parts of the equipment and their functions,
- Operate the machine efficiently and safely,
- Understand major failures/breakdowns associated with the equipment and find solutions for how to fix them, and
- Provide potato planting services to farmers efficiently and profitably.

Session -1: Introduction to potato planting equipment

Learning Objectives:

At the end of the session, participants will be able to:

- Demonstrate awareness of different types of potato equipment available in the market,
- Understand and state the function and usefulness of the equipment for potato planting, and

- Understand and explain the advantages of mechanized potato planting

Session -2: Different Parts of a potato planter

Learning Objectives:

At the end of the session, participants will be able to:

- Identify major parts of a potato planter,
- Understand and state the functions of different parts of the planter

Session -3: Seed and Fertilizer Calibration

Learning Objectives:

At the end of the session, participants will be able to –

- Understand and perform the basic math needed for calibration of seed and fertilizer meter
- Calibrate seed and fertilizer meter properly.

Session - 4: Planter Safety

Learning Objectives:

At the end of the session, participants will be able to:

- Check planter setting and other components
- Check and lubricate, grease all necessary parts
- Join the machine with to a tractor
- Start the machine and operate in the field, and
- Maintain safety of the machine and operate the machine safely

Session -5: Troubleshooting and Maintenance

Learning Objectives:

At the end of the session, participants will be able to -

- Understand and explain common failures/breakdowns of the potato planter
- Make basic repairs and adjustments, and solve different operational problems
- Ensure good maintenance of the machine

Sprayers

Course content to include manually operated sprayers (knapsacks), power operated (backpacks) and tractor operated sprayers and dusters.

Training Aim

The aim of this training is to increase agricultural machinery service providers' awareness and knowledge about manual, power and tractor-operated sprayers and to improve their skill in operating them safely, efficiently and profitably.

Training Objectives

By the end of the training, participants will be able to:

- Understand and explain usefulness of sprayers,
- Identify the major mechanical parts of sprayers and their functions,
- Operate the machine efficiently and safely,
- Understand major failures/breakdowns associated with sprayers and find solutions for how to fix them, and
- Provide spraying services to farmers efficiently and profitably.

Session -1: Introduction to sprayers

Learning Objectives:

At the end of the session, participants will be able to:

- Demonstrate awareness of different types of sprayers available in the market,
- Understand and state the function and usefulness of sprayers for spraying crops and for alternative uses, and
- Understand and explain the advantages of using the different types of sprayers.

Session -2: Different Parts of a sprayer

Learning Objectives:

At the end of the session, participants will be able to:

- Identify major parts of a sprayer,
- Understand and state the functions of different parts of the sprayer

Session -3: Sprayer Calibration

Learning Objectives:

At the end of the session, participants will be able to –

- Understand and perform the basic math needed for calibration of sprayers for different applications,
- Calibrate sprayers and use them properly in the field.

Session - 4: Sprayer Safety

Learning Objectives:

At the end of the session, participants will be able to:

- Check sprayer setting and other components
- Demonstrate basic understanding of agrichemicals and their uses
- Understand possible side effects of exposure to agrichemicals
- Understand safe storage of agrichemicals
- Understand safe transportation of agrichemicals
- Understand safe use of agrichemicals

- Understand safe disposal procedures of agrichemicals

Session -5: Troubleshooting and Maintenance

Learning Objectives:

At the end of the session, participants will be able to -

- Understand and explain common failures/breakdowns of the sprayers
- Make basic repairs and adjustments, and solve different operational problems
- Ensure good maintenance of the machine

Managing Service Provision as a Business

Course content to include:

- Entrepreneurship and management in the hire service business.
- Hire service business organization.
- Managing hire service business operations.
- Managing financial aspects of the hire service business.

Training aim

The aim of this training is to increase agricultural machinery service providers' awareness and knowledge about running their service provision efficiently, profitably and in a way that is environmentally friendly

Training objectives

At the end of the session, participants will be able to:

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

Session -1: Entrepreneurship and management in the hire service business

Learning objectives:

- Understand the difference between entrepreneurship and management.
- Describe what management is and what is involved in managing a hire service business. Why is good management important?
- Understand the main management skills of diagnosis, planning, organization, leadership and control.
- Describe what managing business operations means in a hire service business and why good management is important.
- Understand the importance of managing a hire service business in an environmentally friendly way.
- Understand the importance of risk and learn how to deal with it.

Session -2: Hire Services Business Organization

Learning objectives:

- Understand the importance of organization.
- Describe what business organization means for a hire service and why it is important.
- Describe the importance of ownership, partnerships, laws, staffing, and supplier and customer relations in managing the hire service business.

Session -3: Managing Hire Service Business Operations

Learning objectives:

- Describe what is meant by managing operations.
- Understand the importance of managing the operations of the business.
- Demonstrate how to prepare a schedule of operations.
- Describe some of the ways operations can be planned and controlled.

Session -4: Managing Financial Aspects Of The Hire Services Business

Learning objectives:

- Explain the concept of profit and show how it can be calculated.
- Understand how custom hire charges for services are set.
- Stress the importance of business planning and explain how to prepare plans.

Appendix 3: List of participants and contacts – Class 1

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