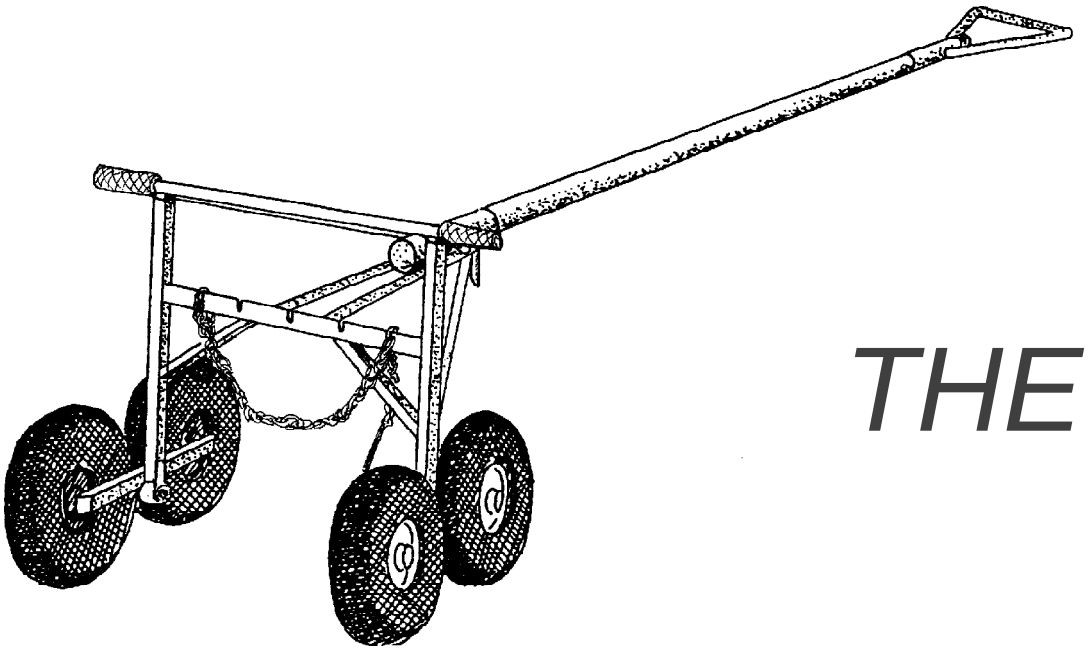
APPRODEV REFERENCE MANUAL - PART 3

*PRACTICAL INFORMATION COLLECTED FROM THE APPRODEV PROJECT ON THE SULKY - **FOR SUPERVISORS, LOGGING TEACHERS AND WORKERS***



THE SULKY

ABOUT APPRODEV TRAINING MATERIAL

- These reference manuals contain information on the subjects that were found relevant during the development and training activities of the APPRODEV project in East and Central Africa.

- This particular manual on *the sulky* is written for the level of:

  supervisors, logging technology teachers and workers

- The manuals are suggested for use as reference information for short training courses or elements of curricula. If you require further information on the subject you will find **references** listed in the **contents section** on the following page.

- The reference manual is most effectively used in conjunction with the workbook, which provides various tasks and exercises for the purpose of analysing and understanding the subject.

- This particular manual is also supported by the following materials:

  workbook 3
  wall posters the parts and use of the sulky
  overhead transparencies of selected drawings/pages

PARTS OF THE APPRODEV REFERENCE MANUAL

1 *- Logging Management*
2 *- Oxen Logging*
3 *- The Sulky*
4 *- Hand Tools*

- *Manual design, research and texts by Mark Seymour (update 1996)*
- *Drawings by Veijo Kangasmäki and (Mark Seymour)*

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APPRODEV PROJECT

"DEVELOPMENT AND PROMOTION OF APPROPRIATE TECHNOLOGY FOR ENVIRONMENTALLY AND ECONOMICALLY SOUND FOREST HARVESTING"

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Finnish International Development Agency

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INTRODUCING THE SULKY * History * Types of sulky * Uses of the sulky * Advantages of the sulky * Key points for successful use	5	* **Heikkilä TA** 1988, Bogie Skidding Sulky Manual FTP Publication 23, Helsinki * **Fosser E** 1987, The Use of Logging Sulkies (from ILO workshop proceedings - the transfer of basic technology from the ECE region) ILO Geneva
HOW TO USE THE SULKY * The team * Loading * Moving with the sulky * Unloading * Sulky maintenance	14	
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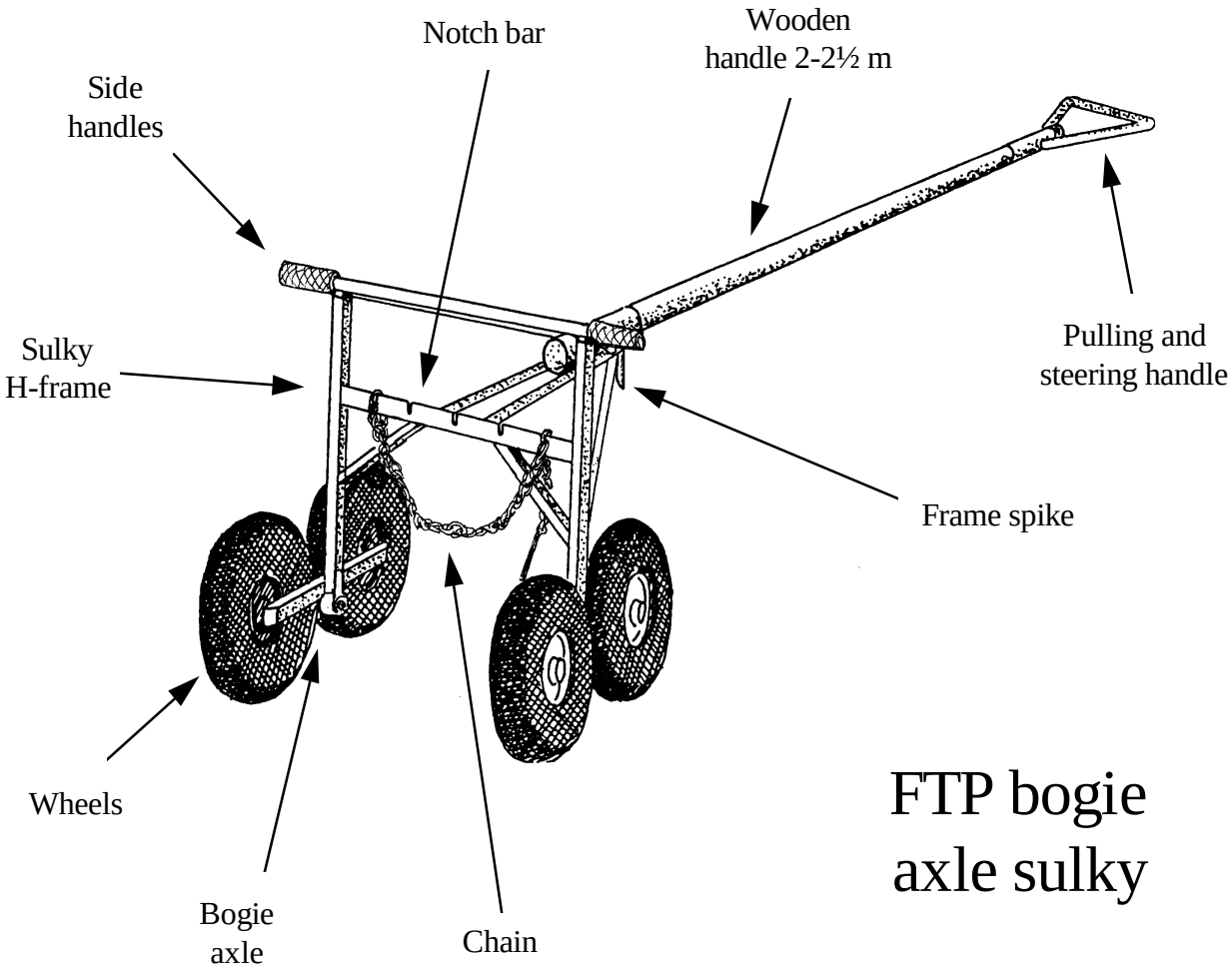
FURTHER SULKY USES * Releasing hang-ups * Gravity cable systems * Draught animal sulky	7	* **Heikkilä TA** 1988, Bogie Skidding Sulky Manual FTP Publication 23, Helsinki

THE PARTS OF A SULKY



FTP bogie axle sulky

Notes:

INTRODUCING THE SULKY

1 History

The log arch has been used in various forms throughout the years for transporting logs from the felling site. From early horse drawn sledge arches to the log arches used on modern skidders, the principle of lifting the log partly, if not completely off the ground for transport is a sound one. Friction and soil disturbance are reduced and the logs will collect less of the mud and dirt which can damage the machinery of the wood sawing and pulping industries.

The manual log arch, or sulky, has been developed as an intermediate level forestry tool to combine low investment and running costs with an efficient log forwarding capability. With the FTP type sulky, loads of up to 400 kg can be transported - single logs or bunches of smaller logs and fuelwood can be forwarded completely off the ground, or long poles can be skidded with one end on the ground. The sulky is operated by manpower alone or used in combination with draught animals.

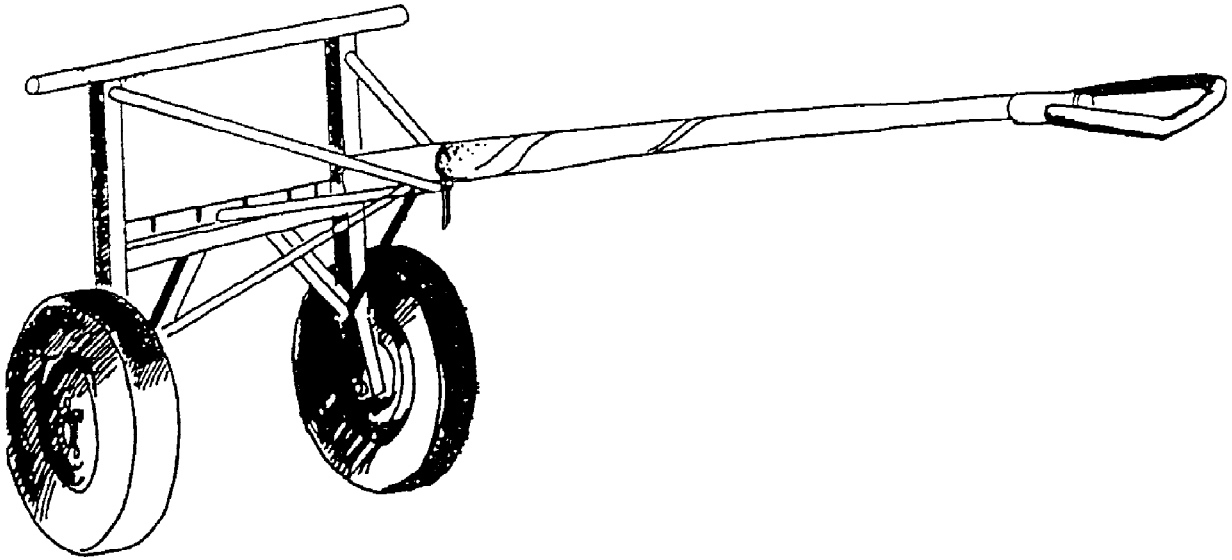
Early development of the sulky for use in Tanzania was carried out in the 1970s by the International Labour Organisation (ILO) and the Royal Norwegian Development Agency (NORAD). Subsequently, the Finnish International Development Agency (FINNIDA) under the auspices of the Forestry Training Programme (FTP International) has continued to develop and promote the sulky into the tool presented in this manual. The H-frame bogie axle sulky, designed by FTP's sulky specialist Mr. Timo A. Heikkilä, is perhaps the ultimate improvement of the manual sulky.

Notes:

2 Types of sulky

There are two types of sulky developed and promoted by FTP, both featuring the rigid **H-frame**. The **bogie axle type** is more difficult to manufacture but is more efficient in use. The **two wheel type** is easier to manufacture but heavier to pull.

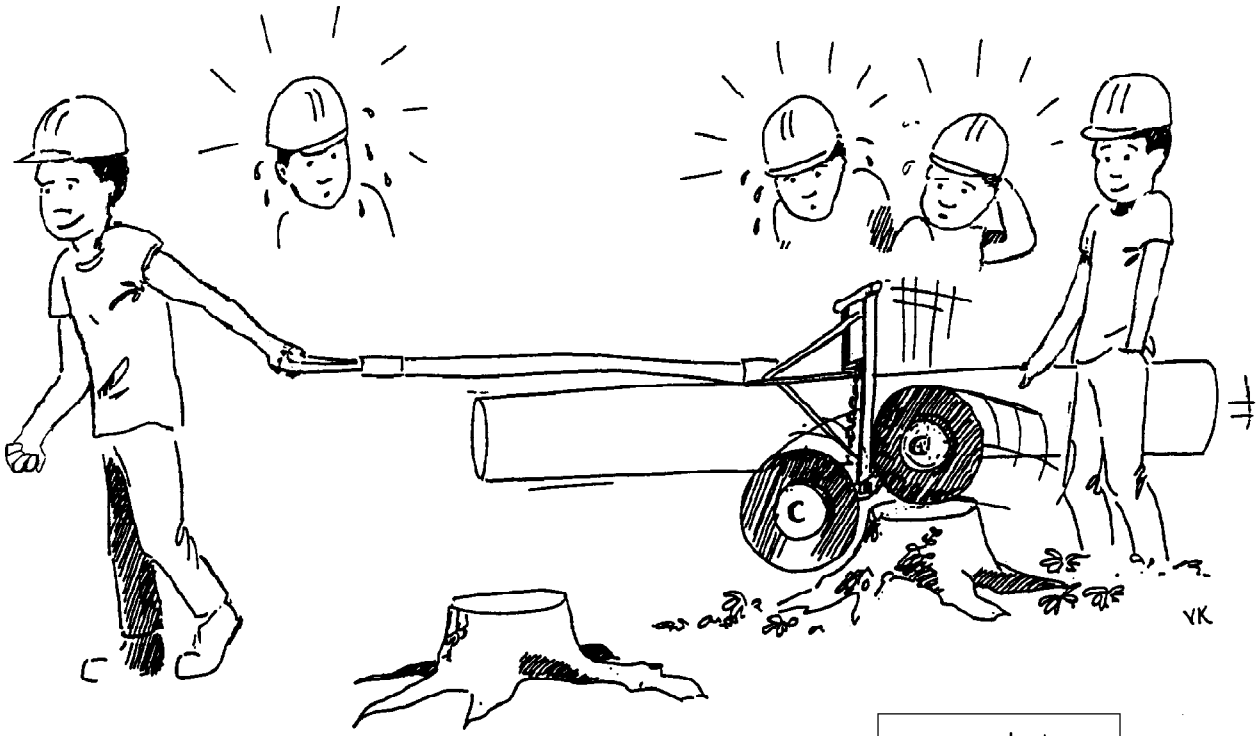
A) Two Wheel Sulky



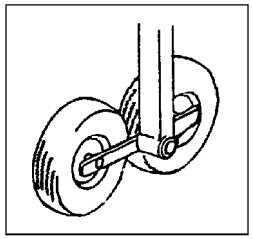
The advantage of this model is ease of manufacture. The two wheel sulky can be made using old **car wheel and hub units**. For instance, 10 - 14 inch wheels are suitable and can be found in most scrap yards along with the hub and bearing.

Notes:

B) Bogie Axle Sulky



"Climbs easily over obstacles!"



The bogie axle gives the sulky four wheels, two on each axle (shown above). The bogie can rotate completely around, meaning that it easily climbs obstacles such as **tree stumps** and **branch waste** and does not easily become stuck in **ditches**.

Notes:

3 Uses of the sulky

- Primarily, to transport wood from the stump to the roadside landings by **forwarding** (lifted from the ground), such as single logs or bunches of logs or fuelwood, or for **skidding** long poles (one end of load skids on ground).

- The FTP model sulky can carry loads of up to **400 kg,** with logs or bunches of logs up to **55 cm in diameter**.

- **Good productivity**, relatively **low investment** and very **low running costs** make the sulky a cost effective option for the following examples:

  - for **plantation logging** operations with logs or poles under 55 cm diameter;
  - to **replace manual carrying** of wood over distances greater than 5 metres;
  - as an **alternative to forestry tractors**: where these are not available or unreliable, or where their skidding cost per m^3 is higher than using the sulky, e.g. distances under 100 metres and where labour is relatively cheap;
  - where it is important to **minimize environmental damage** from logging.

- Also an excellent solution for taking down **lodged trees** (hang-ups), see the section on *"removal of hang-ups"*.

- Can be used in combination with animals such as **oxen**, making the sulky into a log trailer, see *"draught animal sulky"*.

- Can be used as a **steep terrain** transporting method using gravity and two sulkies, see *"gravity cable system"*.

WHERE TO USE THE SULKY

For logs or poles less than 55 cm diameter

For bunches of small wood such as fuelwood

To replace manual carrying or rolling over more than 5 metres

Where tractors are not available, not reliable or too expensive per m^3 skidded

To minimize the environmental effects of logging

Excellent for safe removal of hang-up trees

Notes:

4 Advantages of the sulky

- A safer alternative for forest workers than manual methods such as log rolling, giving **better ergonomics** and **fewer accidents**.
- When used in conjunction with a **piece rate payment system** the sulky can be particularly **productive** and provide **good motivation** for workers.
- Provides **clean logs** and a **clean logging site**. Compared to tractor skidding or log rolling the logs collect much less mud and sand to blunt wood processing machinery. Also, the **topsoil** at logging sites is **not disturbed** and there are **smaller and less skidding tracks** in the forest, i.e. **no environmental damage**.
- **Local manufacture** possible in most countries and only **basic maintenance** is required (tyre pressures, greasing open bearings, replacing wooden handles).

5 Key points for successful use

- Make sure the **sulky construction quality is good**, e.g. a straight frame, good quality welding and good quality wheels, bearings and tyres (most wheelbarrow wheels are not suitable for forestry use).
- Make sure **workers are correctly trained, motivated and supervised**, e.g. correct balancing of the log in the frame must be constantly checked.
- Make sure that **spare handles and tyres** are available **at the logging site** in the event of breakage.

SUCCESSFUL USE OF THE SULKY

Make sure the sulky is of good quality construction

Ensure well trained and motivated workers

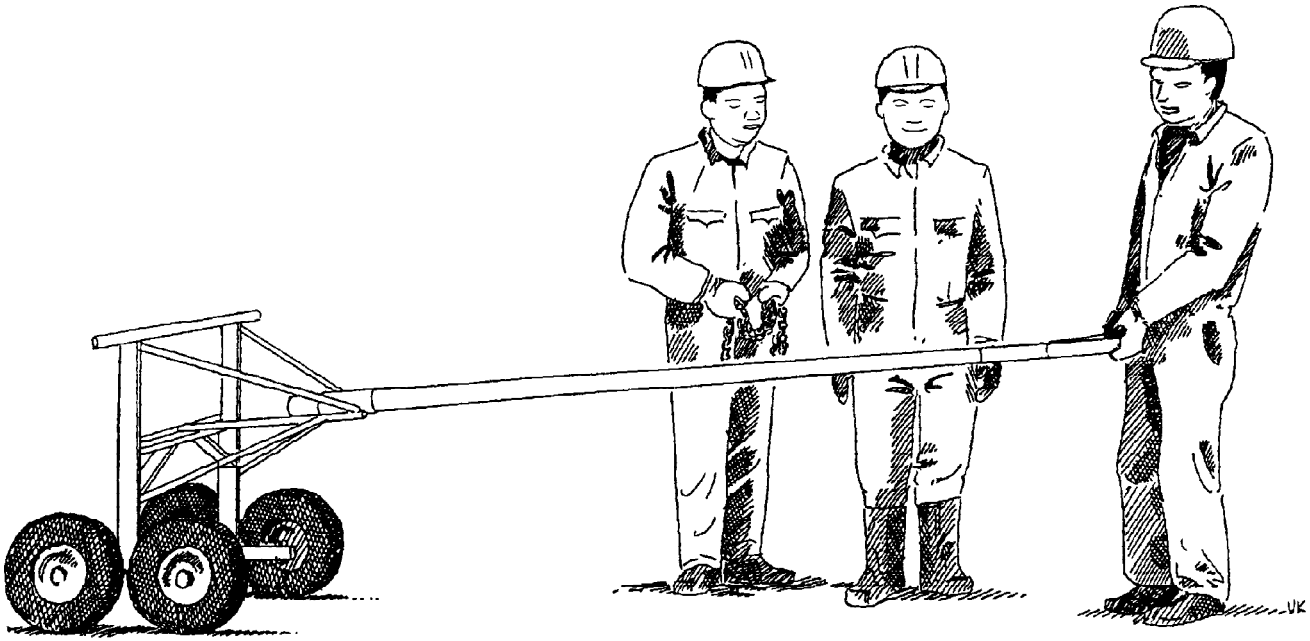
Keep spare sulky handles and tyres in the forest

Notes:

HOW TO USE THE SULKY

1 The team

A team of three to four workers is needed to operate the sulky.



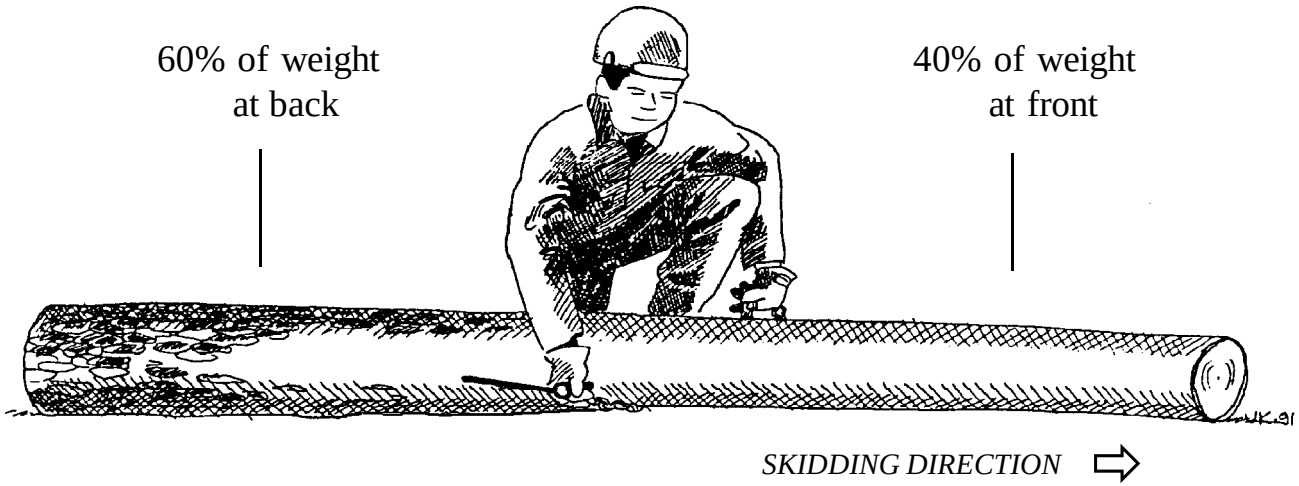
Two workers push from the sulky side handles and one or two workers pull and steer from the steering handle.

Notes:

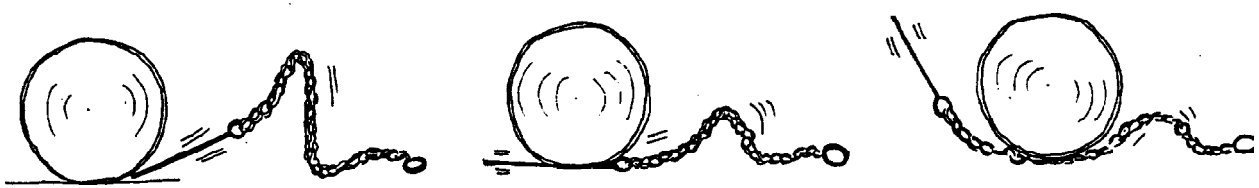
2 Loading

LOADING STEP 1 - Positioning

The **sulky chain** must be put **under the log** (or bunch of logs) in the correct position. Correct positioning takes practice, but the rule to follow is to imagine that the load will be **slightly back heavy** when it is hanging on the chain.



The chain should have a **spike** (or **pin**) welded to one end. This makes it possible to push the chain underneath the log (the log may be too heavy to roll onto the chain).



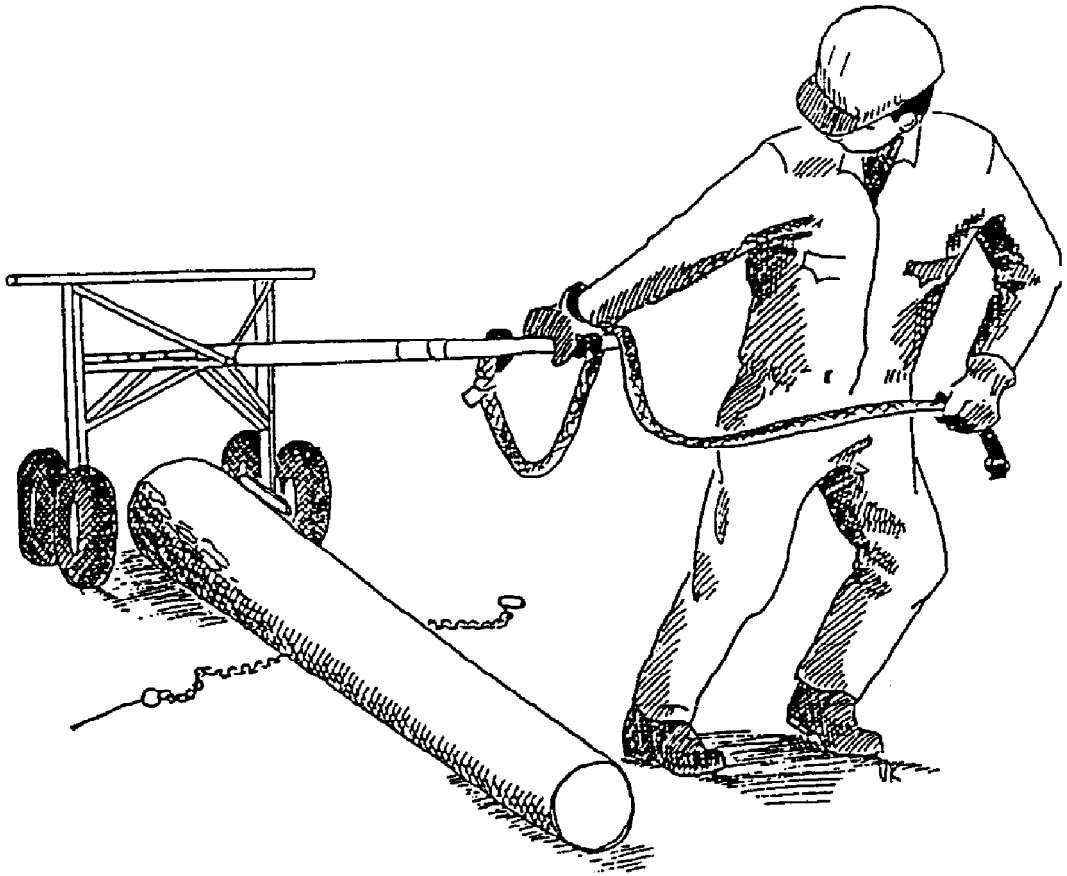
SULKY CHAIN POSITION

- **if the sulky chain is under the load in the wrong place the load will not balance correctly in the sulky**
- **A badly balanced sulky is difficult to drive**
- **the load should slightly back heavy when it is in the sulky**
- **60% at back, 40% at front**

Notes:

LOADING STEP 2 - Pull the sulky over the load

Pull the sulky over the log as shown. Stop when the wheels have run over the chain and when the **sulky is over the front of the load**.



The sulky is **always pulled handle first**. So, it is good to start as you mean to go on, even when loading the sulky.

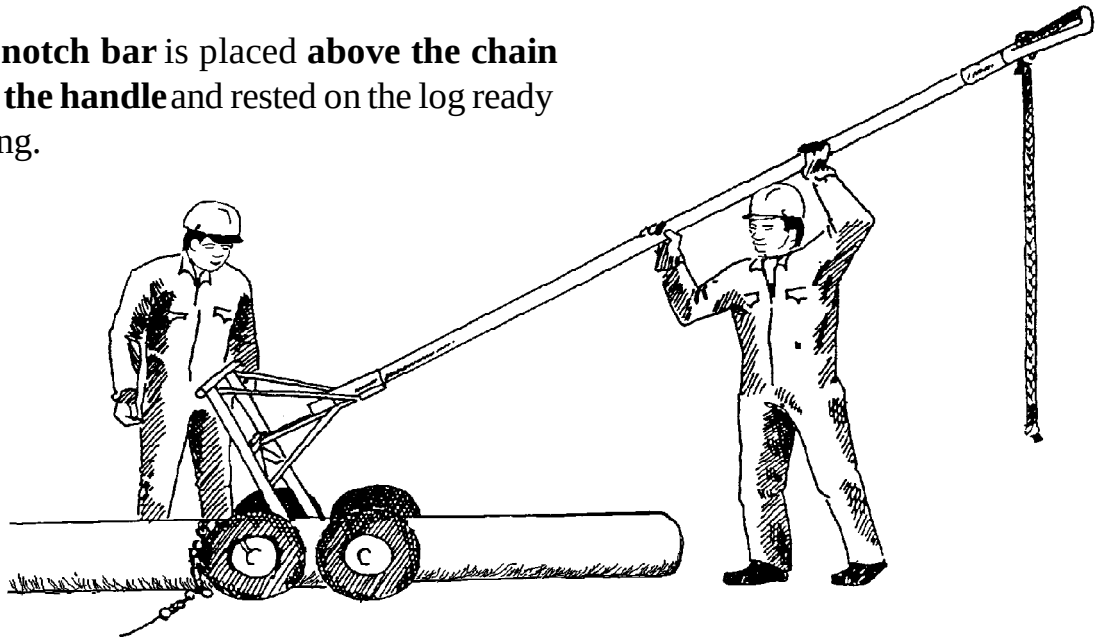
TAKE NOTE !

- **The sulky is pulled handle first**

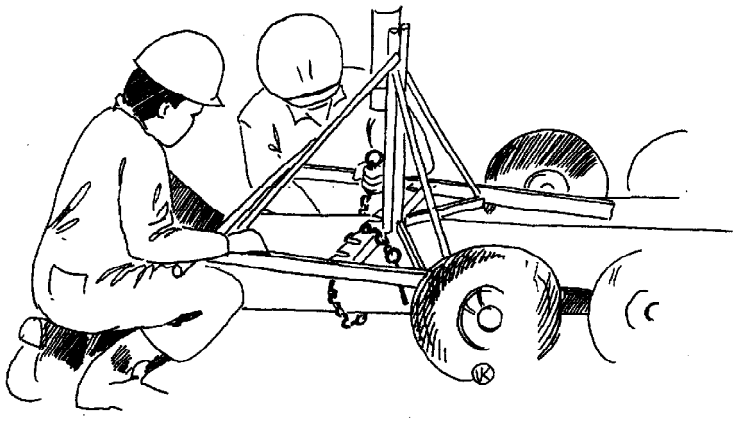
Notes:

LOADING STEP 3 - Couple the sulky chain to the sulky

The sulky **notch bar** is placed **above the chain** by **raising the handle** and rested on the log ready for coupling.

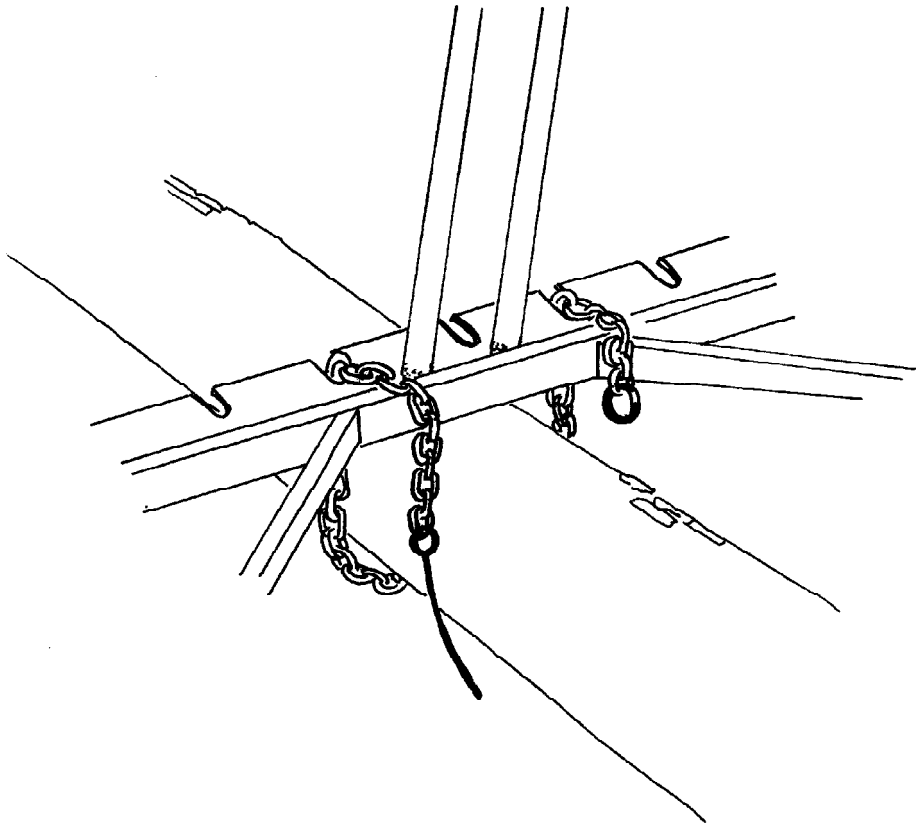


***Coupling**, shown here, is done in one of two ways depending on the type of load to be moved: **single logs or a bunch of logs**.*



Notes:

FOR SINGLE LOGS - THE U-SHAPE COUPLING

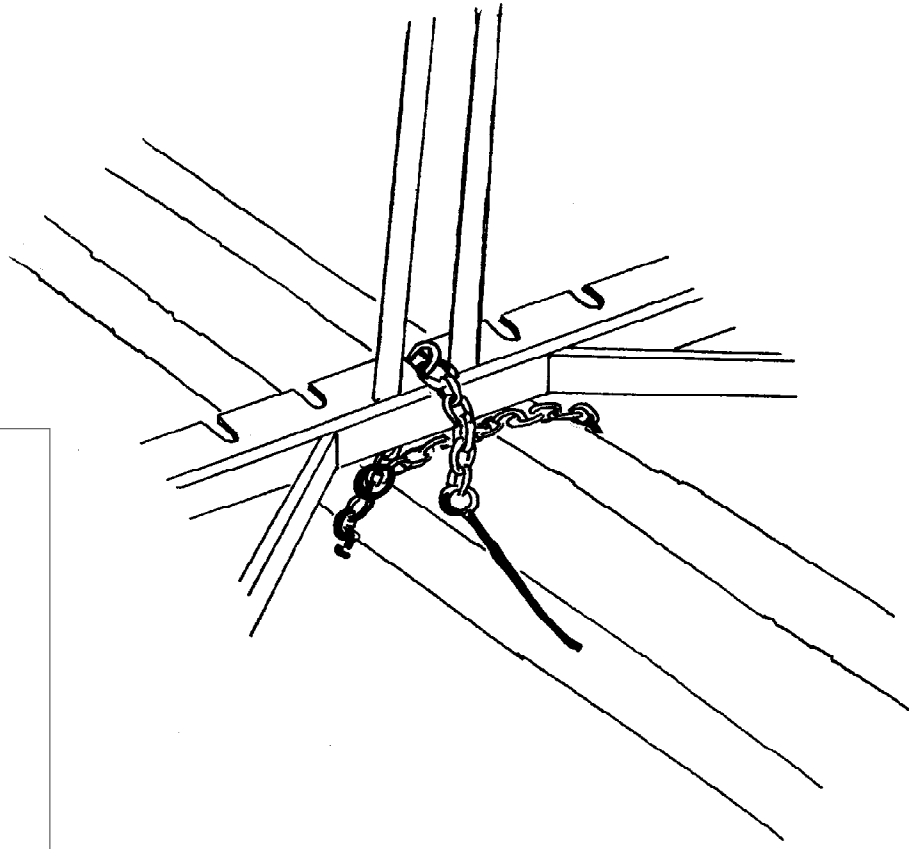


U-shape coupling

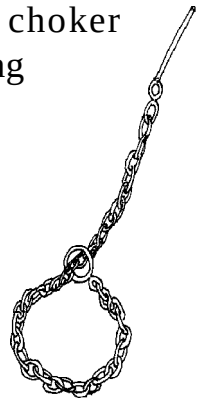
- *holds the log firmly in the frame*
- *chain is coupled into 2 notches on the sulky notch bar*
- *make the chain **loose by 2 or 3 links** (2-3 links less than tight)*

Notes:

FOR BUNCHES OF LOGS - THE CHOKER COUPLING



A choker ring



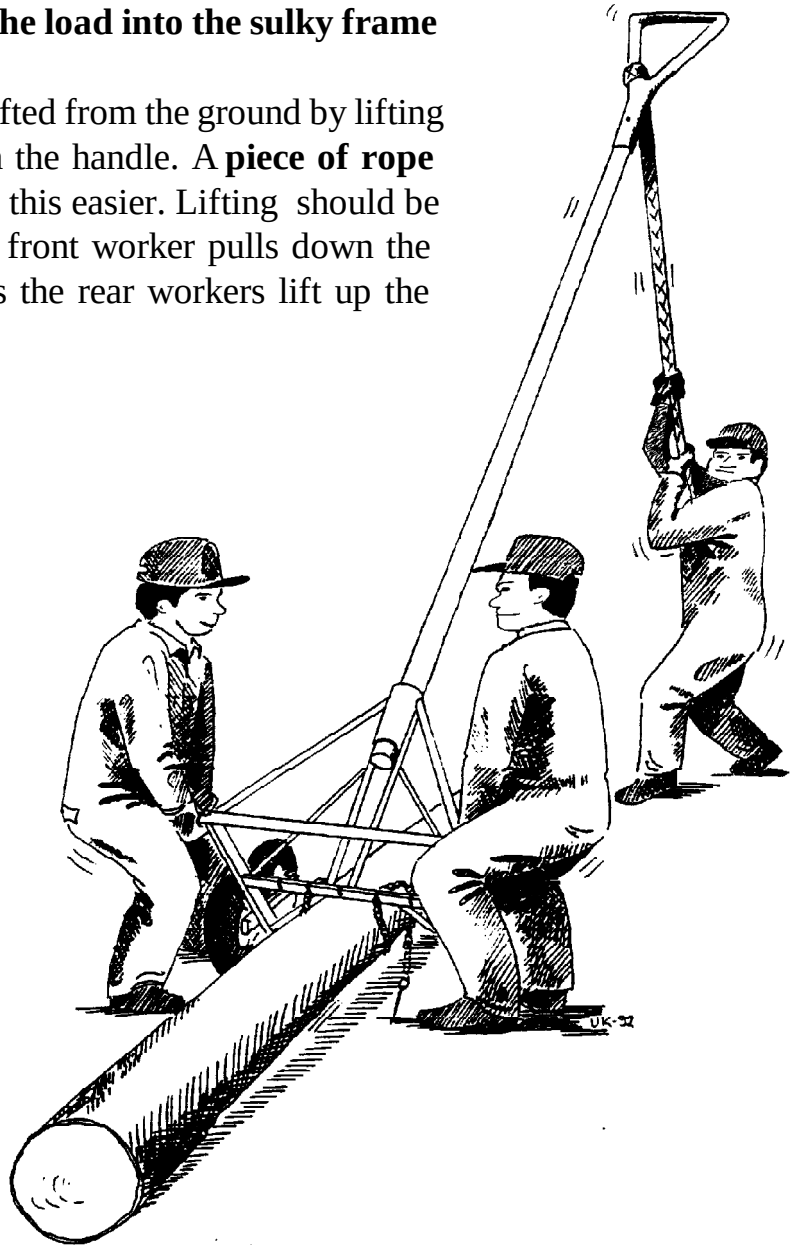
Choker coupling

- *choker ring tightens and holds bunch firmly together as sulky handle raised*
- *chain made into choker ring and free end of chain coupled to 1 notch*

Notes:

LOADING STEP 4 - Lift the load into the sulky frame

The log or bunch of logs is lifted from the ground by lifting the frame and pulling down the handle. A **piece of rope** tied to the handle may make this easier. Lifting should be done with **team work**. The front worker pulls down the handle **at the same time** as the rear workers lift up the sulky side handles.



Lifting power by the workers on the sulky side handles must come from the leg muscles !

- *Bend at the knees*
- *Keep a straight back*

LIFT SAFELY!

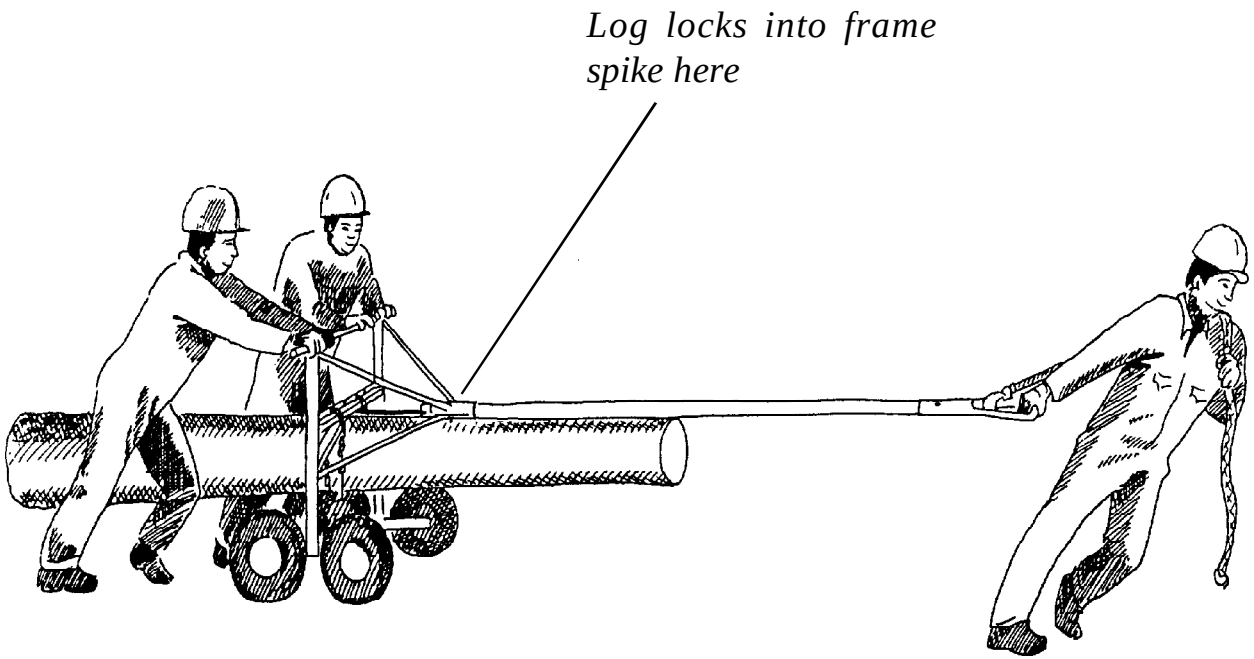
- **Team work is essential, a single worker cannot lift the load alone**
- **Use the leg muscles in lifting by bending at the knees and keeping a straight back**

Notes:

LOADING STEP 5 - Checking the balance

If the chain has been correctly positioned (step 1) and correctly tensioned (step 3) it should be possible to **lock the load into the frame spike** (see sulky label diagram) to stop it swinging during transport.

If the **log cannot be locked** into the spike the chain is either **too loose or too tight** In these cases the load should be **re-coupled** so that the chain is in a better position.



Correct balance of load in sulky frame

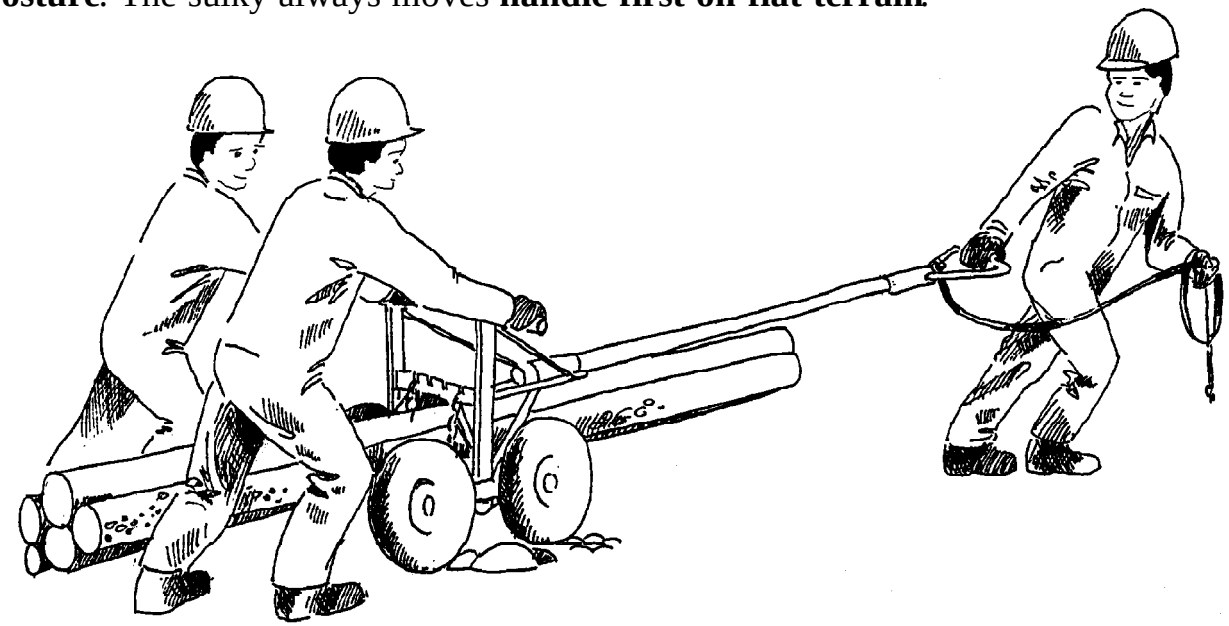
PRACTICE MAKES PERFECT !

- **Getting the right balance is the most important part in training workers to use the sulky**
- **The right balance is where you can lock the load into the frame spike**

Notes:

3 Moving with the sulky

During transport it is again important to use **teamwork** and the **correct working posture**. The sulky always moves **handle first on flat terrain**.

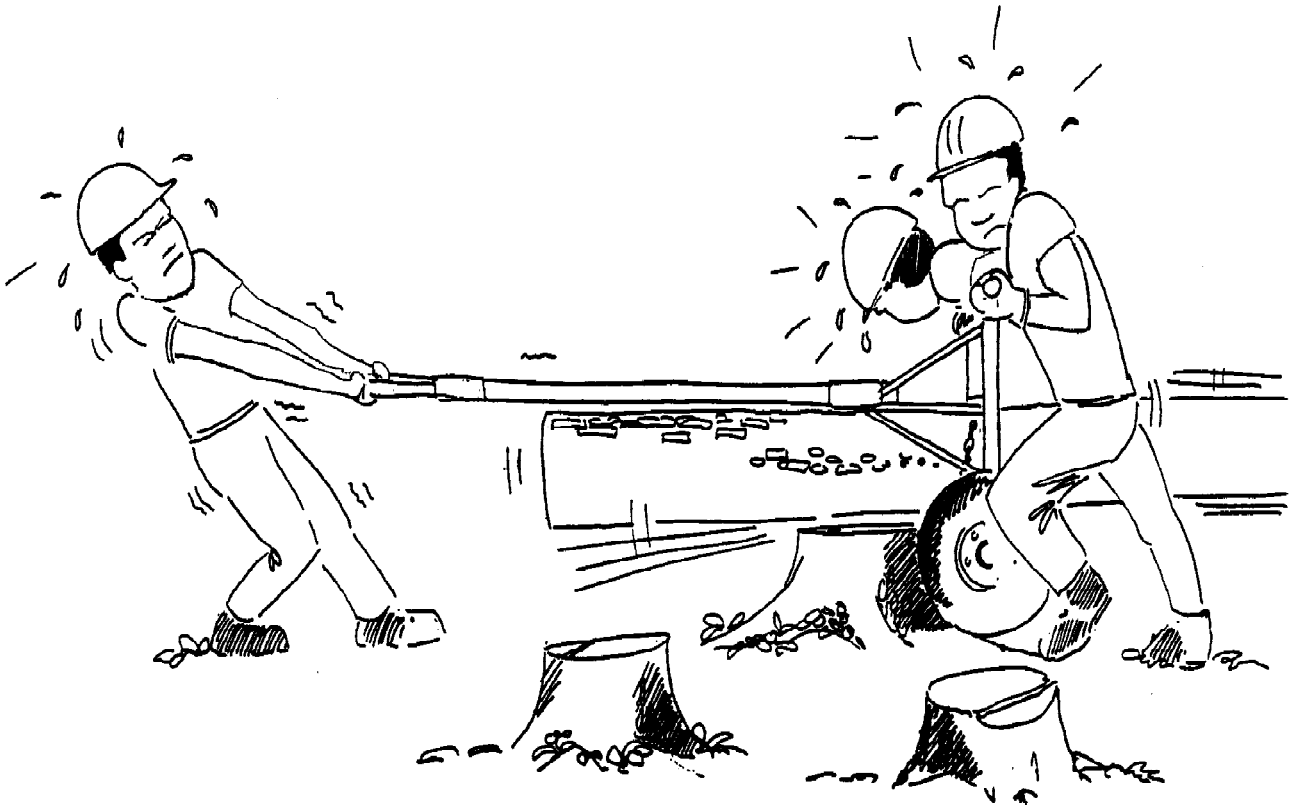


Transporting on flat terrain:

- *Always move **handle first** and **together as a team***
- *Two workers push from the side handles: they provide most of the power*
- *Another one (or two) workers steer and pull the sulky along by the handle*
- ***Keep a straight back** and use of the **leg muscles for pushing and pulling***
- *Working together as a team means that all members move in the same direction and all put in their **effort at the same time!***

Notes:

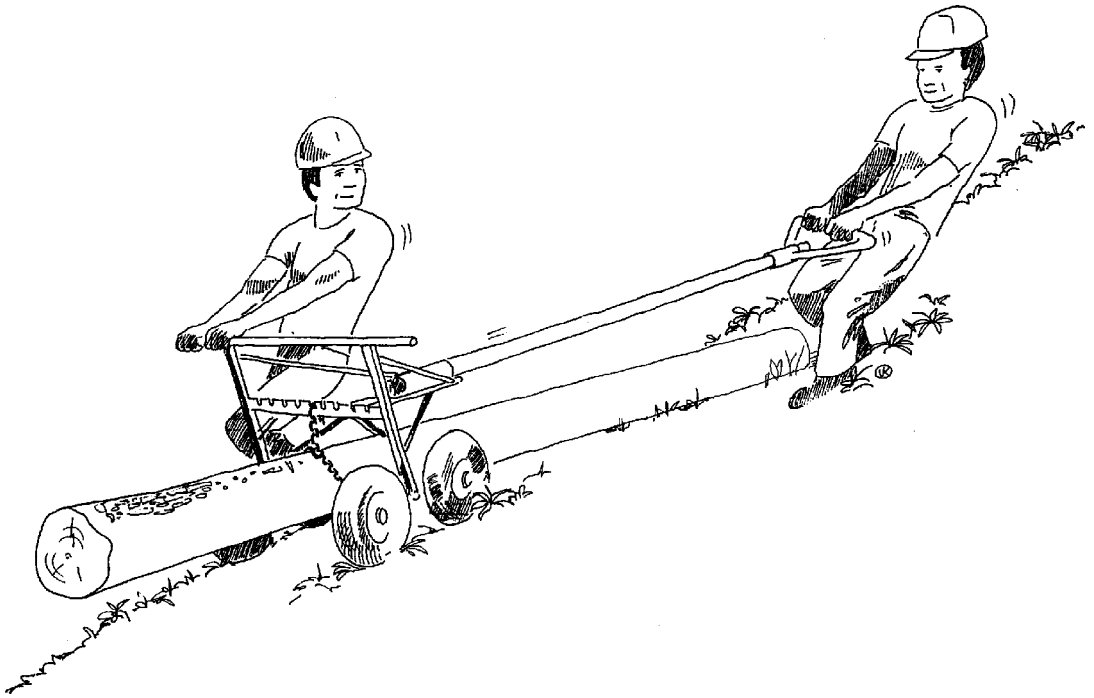
If you are using a **two wheel sulky**, remember that it is not as easy to climb over obstacles as it is with the bogie axle sulky.



Don't make life too difficult with the two wheel sulky, tell the driver to steer around the obstacles before you reach them !

Notes:

GOING DOWNHILL - Controlling a loaded sulky down slopes of **more than 25%** requires some kind of **braking system**. Braking can be achieved by **turning the sulky around** and using a **loose choker coupling**.



Procedure for transporting downhill:

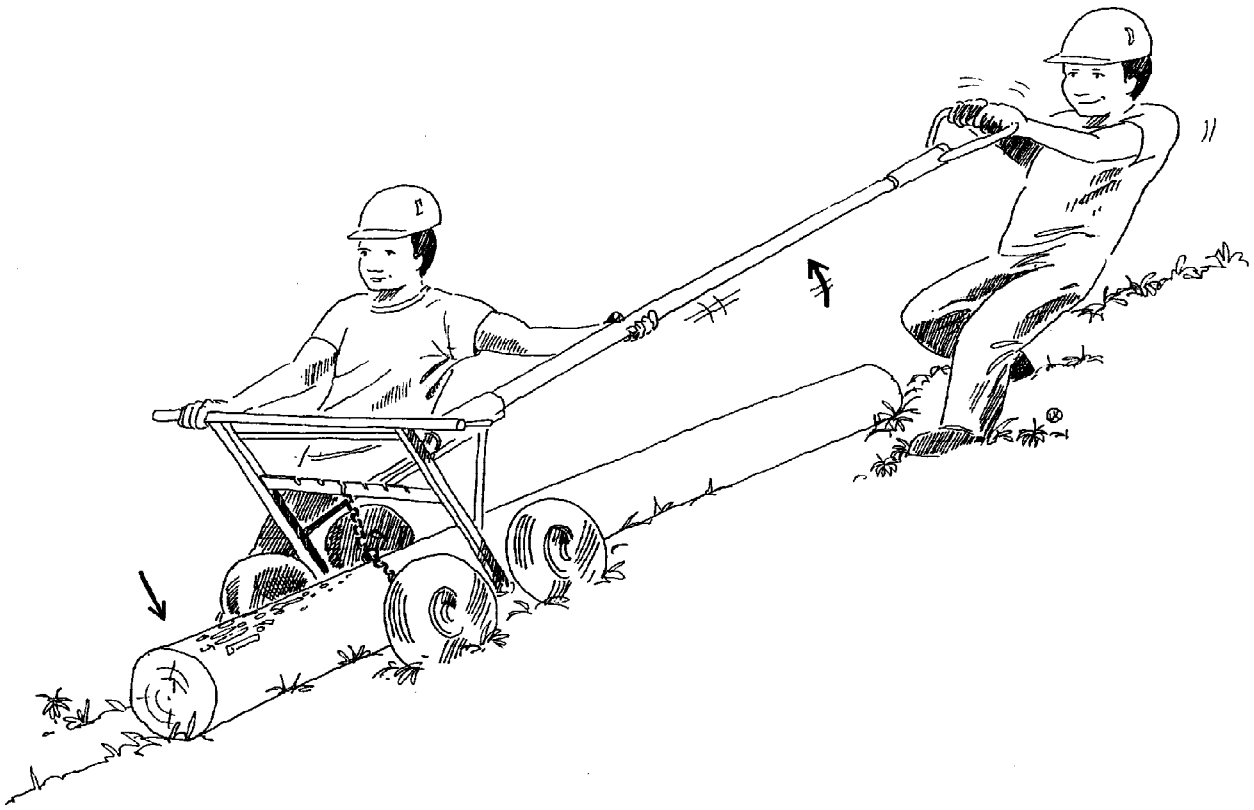
- *Make a **loose choker coupling** and balance the load so that it is very **back heavy**, allowing it to drag on the ground and brake the descent*
- *Turn the sulky around so that one worker can brake the descent by holding the steering handle*
- *Two other workers **firmly grip the side handles** and brake the descent by **holding the sulky back** (only one worker is shown on this diagram)*

DOWNHILL WITH CAUTION

- **Try the downhill operation on less steep hills first**
- **Hang on well to the side handles and steering handle**
- **Don't let go of the sulky**

Notes:

For an **emergency brake** when going downhill the **handle is raised** to allow the front of the log to **dig into the ground** and stop the sulky.



Emergency braking procedure:

- *raise the handle and **let the load dig into the ground** at the front*
- *try not let go of the handle, it helps to keep the rope held in one hand*

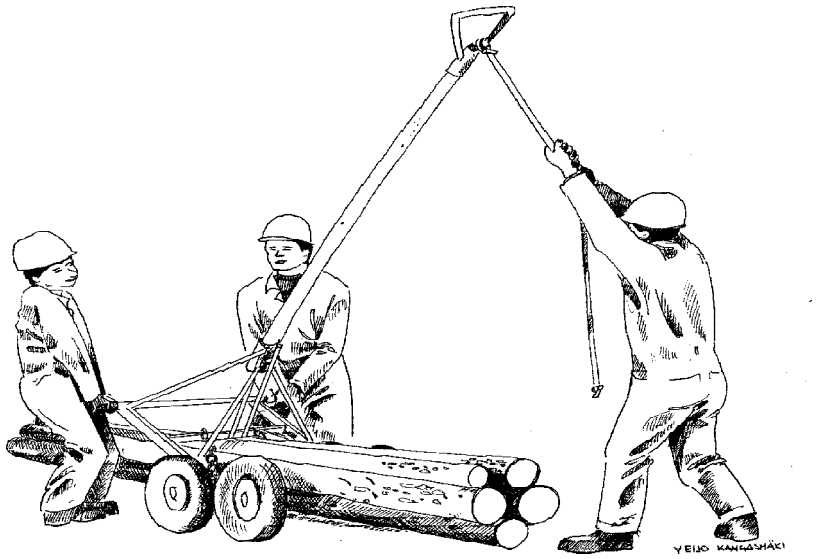
DOWNHILL WITH THE SULKY

- **Turn the sulky around, handle backwards**
- **Use a loose choker coupling**
- **Balance the load to be very back heavy**
- **Raise the steering handle for an emergency brake**

Notes:

4 Unloading

Unloading is the **reverse procedure of loading**. It requires the same team work and effort but **more attention**. Releasing a heavy load **can cause accidents and breakage**



Unloading procedure:

- *Start by raising the handle. **Hold on well to the rope** and don't let the handle raise too fast, it will be difficult to stop. Beware that the load will pull the handle up more heavily as it gets closer to the ground.*
- *Help to **let the load down slowly** by holding on to the side handles as they go down. Workers must use the leg muscles for doing this, **bending at the knees** and **keeping a straight back**.*
- *Uncouple the chain and release the log when safely resting on the ground.*

UNLOAD SAFELY

- **Do not let the handle raise too quickly**
- **Make sure that the workers on the side handle are helping the load down slowly**

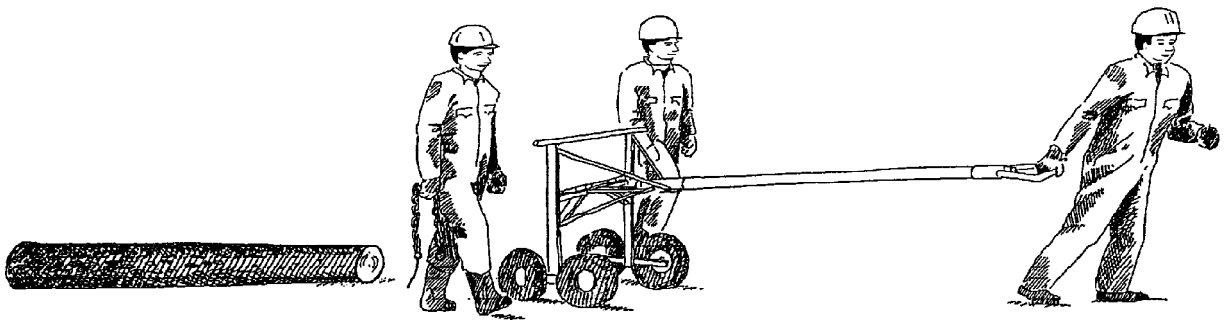
Notes:

5 Sulky maintenance

The FTP type sulky has been designed to be **easy to maintain.** There are some **main points** to be aware of however in order to make a trouble free day in the forest.

Preventive maintenance and quick repair:

- *Keep a **spare wooden handle in the forest**. This handle is designed to be the weakest point of the sulky and the most likely to break in daily use.*
- *If the tyres are inflatable, make sure they have **sufficient air pressure and** keep a **spare wheel and wrench in the forest** in case of a puncture.*
- ***Open type wheel bearings must be greased regularly**. However, most FTP type sulkies use enclosed wheel bearings and are maintenance free.*
- *Check the tightness of the bogie axle securing nut every week. It should be neither too tight or too loose. FTP bogie axle sulkies use a maintenance free sintered bronze bearing which does not need extra lubrication.*



PREVENTIVE MAINTENANCE AND QUICK REPAIR

- **Spare wooden handles and inflated tyres in the forest**
- **Grease any open bearings daily**
- **Check tightness of axle nuts weekly**
- **Check tyre pressures weekly**

Notes:

■ SULKY COSTS AND PRODUCTIVITY

1 Production rates

Several studies have been done by FTP to determine the production rates for the manual sulky transporting wood of various types and in various conditions.

Study description	Terrain	Distance	Slope	Production m^3/sulky/hr
Kotka, Finland May 1988 pine logs (average 0.2m^3)	smooth	50 m	flat	1.4
Kafubu, Zambia May 1991 pine logs (av. 0.15 m^3)	smooth	95 m	flat	1.6 (excluding piling)
Machinga, Malawi September 1992 8m poles (av. 0.2 m^3)	small rocks	180 m 35 m	15% down 10% down	1.2 1.6
Mt.Meru, Tanzania July 1993 pine logs (av. 0.08 m^3)	small rocks	15 m	10% down	2.4
Bislig, Philippines March 1994 falcataria logs (0.31 m^3)	small hills & very muddy	50 m 250 m 45 m	flat flat 35% down	2.8 1.6 1.2

Notes:

2 Sulky purchase prices

During the APPRODEV project numerous H-frame sulkies have been manufactured in several African countries by local blacksmiths and small engineering companies. The prices recorded show that **local manufacture** will make the sulky a significantly cheaper tool in developing countries.

Country	Sulky type	Price in 1993 $US
Finland	H-frame, bogie axle	700
Malawi	H-frame, bogie axle	350
Tanzania	H-frame, two wheel	230
	H-frame, bogie axle (imported)	340
Uganda	H-frame, two wheel	150

2.1 A note on local manufacture

The local manufacture of sulkies is possible wherever a local metalworking and blacksmithing industry exists to provide the **skill**, **raw material** and **welding facilities**.

The greatest difficulty with local manufacture is **quality control**. **Welding must be of good quality** and the **frame must be straight**. The easiest way to begin local manufacture is to provide a **model to be copied** and to **closely supervise the first manufacture**. Also, it may be necessary to import bogie axles and wheels if this model is preferred (see *manufacturing drawings* part of APPRODEV manual).

LOCAL MANUFACTURE OF SULKIES

- **Local manufacture is cheaper than importing**
- **Provide a model to copy**
- **Ensure good quality welding and a straight frame**

Notes:

3 Sulky logging costs

The cost of transporting wood from the stump to the roadside depends very much upon the type of wood, the **terrain**, the **transport distance** and the **motivation and efficiency** of the workers.

However, the studies that have been done on the sulky show it to be **very cost effective** when compared to more manual methods or when compared to tractors working over short distances (less than 100 metres).

3.1 Two logging cost examples

APPRODEV study in Malawi (*1992, "Polewood extraction ..."*)

- *skidding **poles** (0.08m³) over **180 metres***
- *skidding cost including collection from stump and piling of **$US 4/m³ for the sulky** compared to **$US 6.4/m³ with a manual carrying method***

APPRODEV study in Tanzania (*FTP Report 1993:26*)

- *forwarding **small logs** (0.2 m³) over **50 metres***
- *cost of **$US 0.7/m³** including piling*
- *breakdown of costs was as follows:*
  - ***labour costs**: 0.6 $US/m³ using a **piece rate payment system***
  - ***machine cost**: 0.1 $US/m³ using a **locally manufactured two wheel sulky***

COST ADVANTAGE OF THE SULKY

- **Cheaper than manual carrying with distances over 5 metres**
- **Cheaper than tractors with distances under 100 metres**

Notes:

4 Sulky piece rate payment system

Paying workers for each log transported (piece rate) instead of a daily wage works very well with the sulky. **Production rates** can rise dramatically due to the **high motivation** of the workers. The workers also take care of the **maintenance** of the sulky in order to maintain their production.

One disadvantage with the piece rate system is the need to **strictly monitor** the operation to ensure fair play in log recording. It is also very important to set the piece rate at the **correct level** in order to achieve the desired result.

Therefore, it makes sense to use a very **straightforward calculation** for setting the piece rate which can be understood by the workers and easily followed up by management. APPRODEV has carried out studies in Tanzania to develop such a simple calculation.

4.1 Suggested piece rate calculation

APPRODEV sulky piece rate formula:

$$\frac{\textit{(worker's basic daily wage) x (no. workers per sulky)}}{\textit{realistic production target for the site (logs/day)}} = \textit{piece rate/log/sulky}$$

PIECE RATE PAYMENT SUITS THE SULKY WELL

- **Workers view the sulky as a means to do good work and earn well**
- **Workers maintain the sulky to work without breakdowns**
- **Logging contractors can guarantee good use of their investment in the sulky**

Notes:

Example from Tanzania:

$$\frac{\text{\$US 1 per day} \times \text{3 workers per sulky}}{\text{30 sawlogs per day}} = \text{0.1 \$US/log/sulky crew}$$

Points to remember with the piece rate:

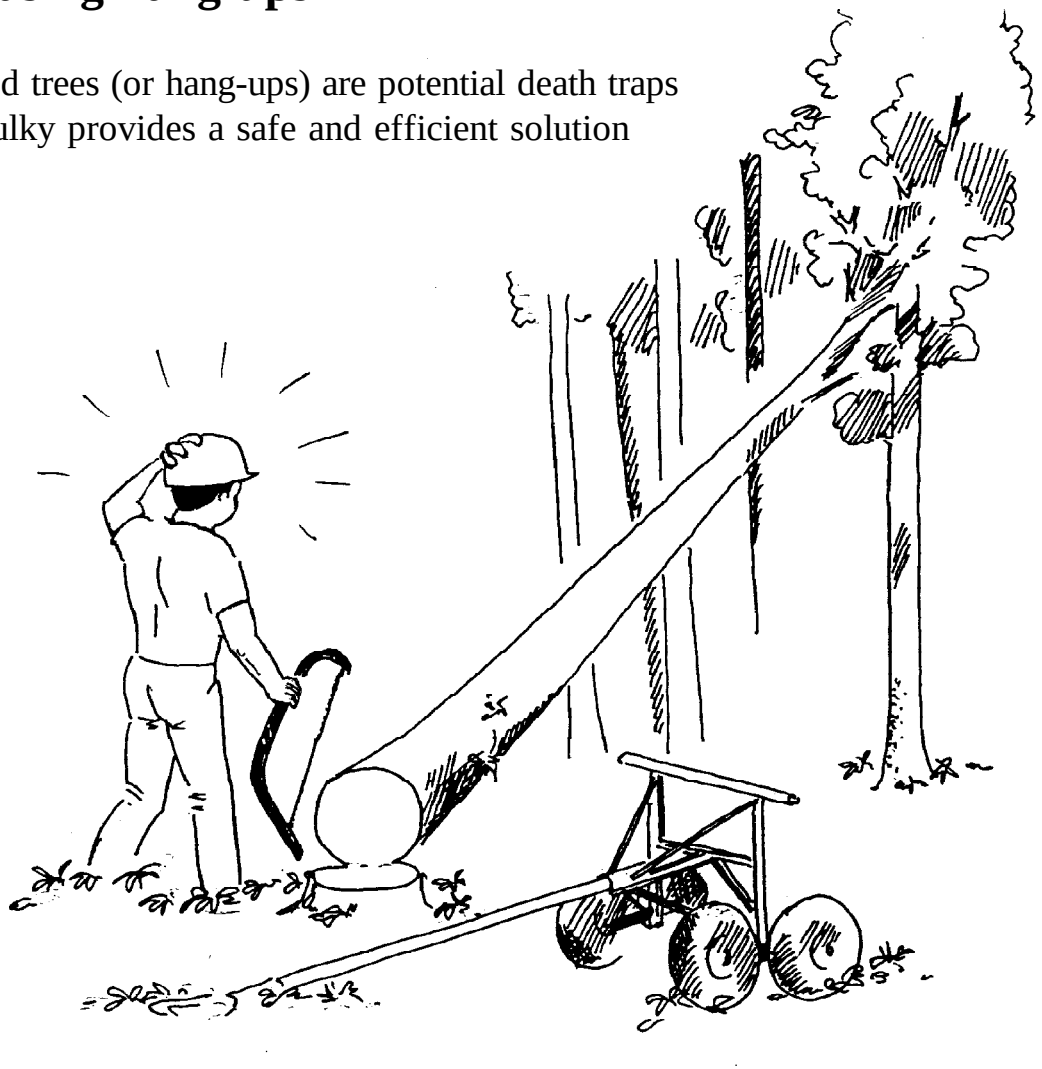
- *Any logs transported in excess of the target will* ***improve*** *the workers' daily* ***wage****.*
- *This gives* ***no risk to the logging contractor*** *of under productive workers or high logging costs:*
  - ***unless****, the target for the site is set at a too high or too low level;*
  - ***or*** *if the log tally worker is untrustworthy, e.g. not of suitable status and responsibility, earning less than the sulky workers.*

Notes:

FURTHER SULKY USES

1 Releasing hang-ups

- Lodged trees (or hang-ups) are potential death traps
- The sulky provides a safe and efficient solution



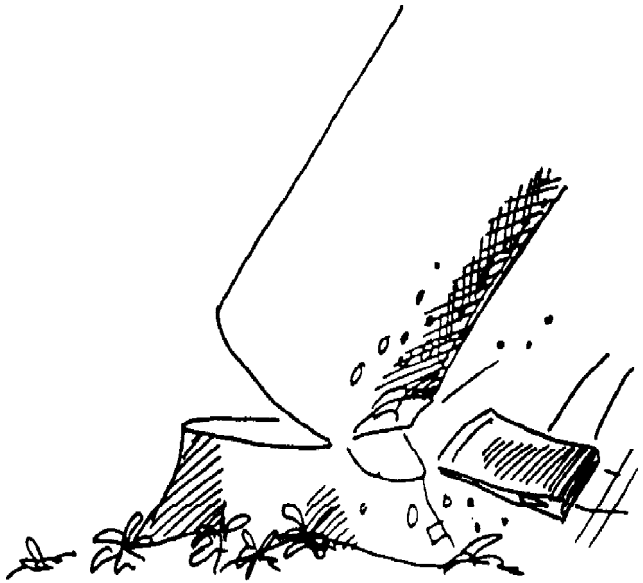
Notes:

1.1 Hang-up release procedure

It is very important to correctly follow the procedure of steps (1-5) in order to achieve the safe removal of a hang-up.

STEP 1 - Cut away the holding wood

The holding wood (or **hinge**) is the section of wood left between the felling sink and the back cut during the felling process. This directs the fall of the tree and gradually rips apart as the tree falls to the ground. With a hang-up tree however it is still connected to the tree stump and must be cut away before the tree can be released to fall.



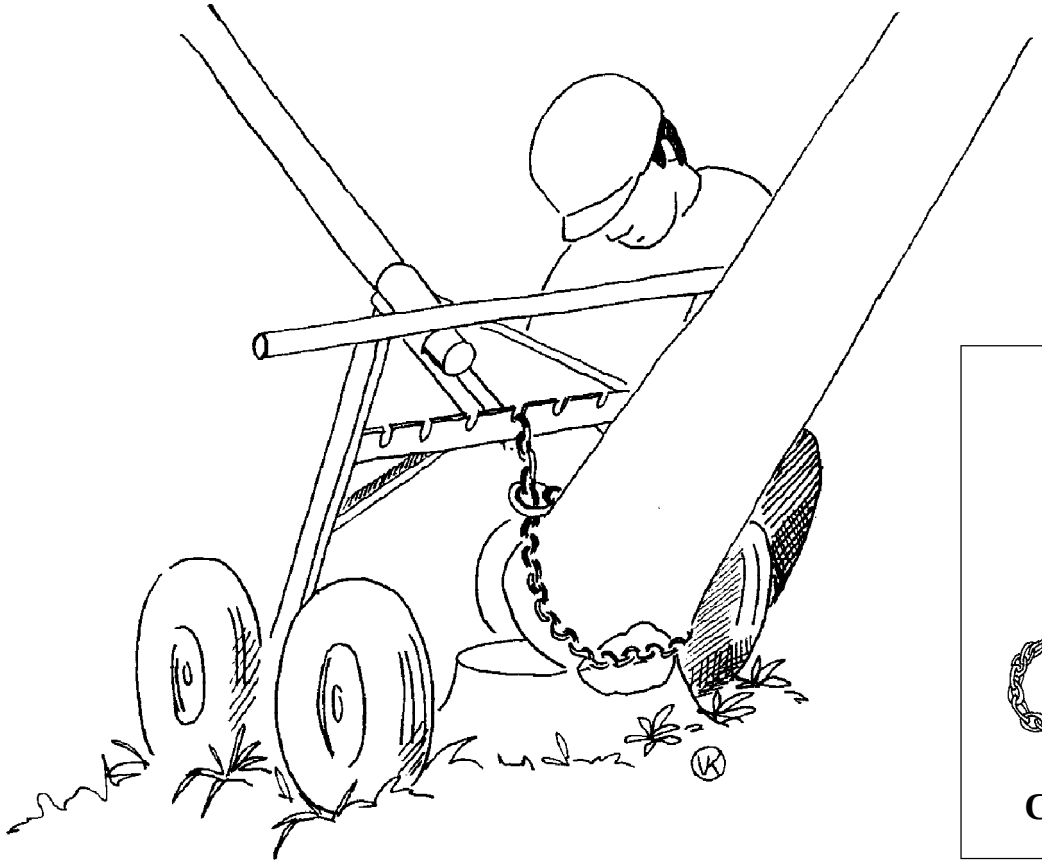
The following points must be observed:

- *cut the holding wood carefully and completely and **DO NOT** work or walk under the lodged tree*
- *an axe is the safest and most efficient tool to use since it has a long handle*
- ***DO NOT** roll the stem off the stump when the holding wood is cut*

Notes:

STEP 2 - Fix a choker loop around the tree stem and couple to the sulky

reverse the sulky towards the stump
raise the sulky handle to bring the notch bar close to the stem
make a choker loop with the chain to grip the bottom of the stem
couple the free end of the chain into the sulky notch bar



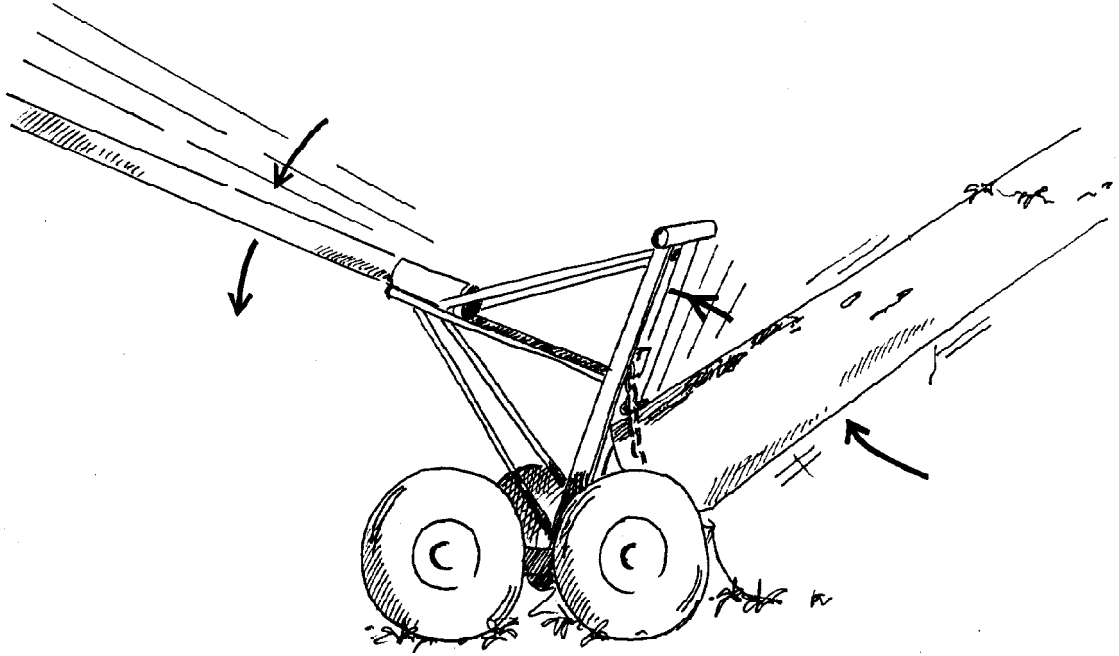
Choker loop

Notes:

STEP 3 - Clear an escape route in front of the sulky

As the hang-up **stem is pulled up and off the stump** in STEP 4 the sulky must move forwards (handle first). This may happen quite quickly and the path for the sulky must be well cleared in advance. This means, **no branch waste, logs or bushes** in the path for some **15-20 metres**.

STEP 4 - Pull down the sulky handle



Pulling down the handle so that the stem starts to lift off the stump should be **just about easy enough for one worker**. If the stem does not lift at all it means that the holding wood has not been completely cut away in STEP 1.

Notes:

CAN'T PULL DOWN THE HANDLE ! ?

Do not force the handle - it will break

STEP 4 should be just about easy enough for one worker

The holding wood was not completely cut in STEP 1

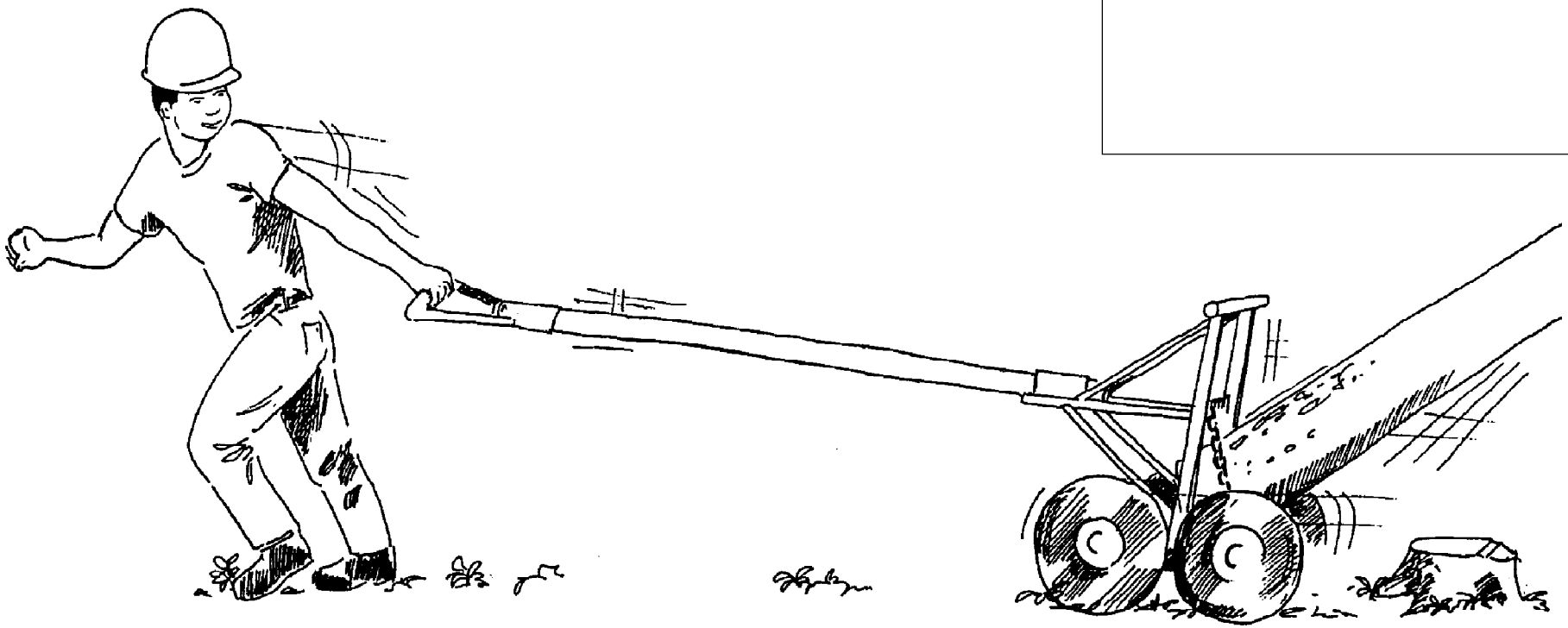
Uncouple the sulky and carefully repeat STEP 1

STEP 5 - Pull the sulky and the stem along the escape route

As the sulky **handle is pulled down** in STEP 4 it will be possible to **pull the hang-up stem away** from the standing tree on which it is stuck (STEP 5).

Hold onto the handle as you pull and KEEP IT HELD DOWN.
Raising the handle will make the stem dig into the ground and stop.
The release of the tree stem may happen quickly, so **be prepared to move quickly** and try not to suddenly let go of the handle - it may spring upwards and cause an accident to another worker.

Notes:

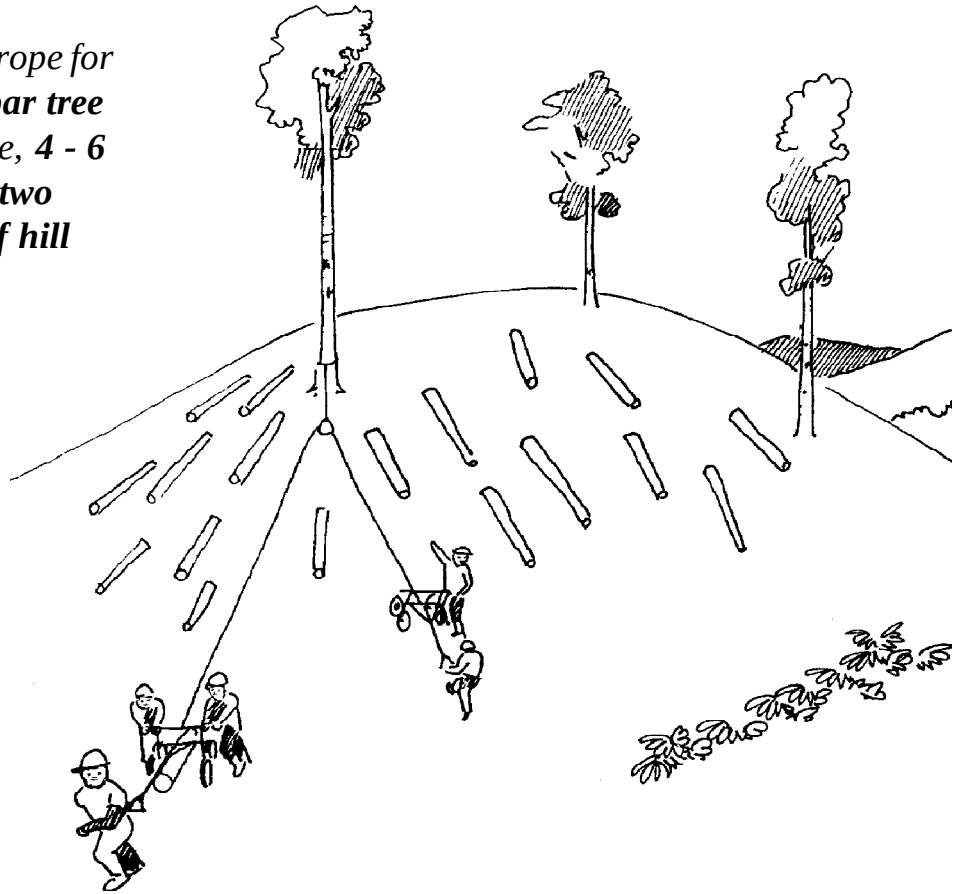


2 Gravity cable systems

Two sulkies can be connected by cable for logging in steep terrain. The two sulkies are connected on either end of a wire rope (cable) and as one sulky moves downhill the other moves uphill. The **unloaded sulky** acts as a **brake** for the loaded one **in downhill logging** or as a **pulling force in uphill logging**

Requirements:

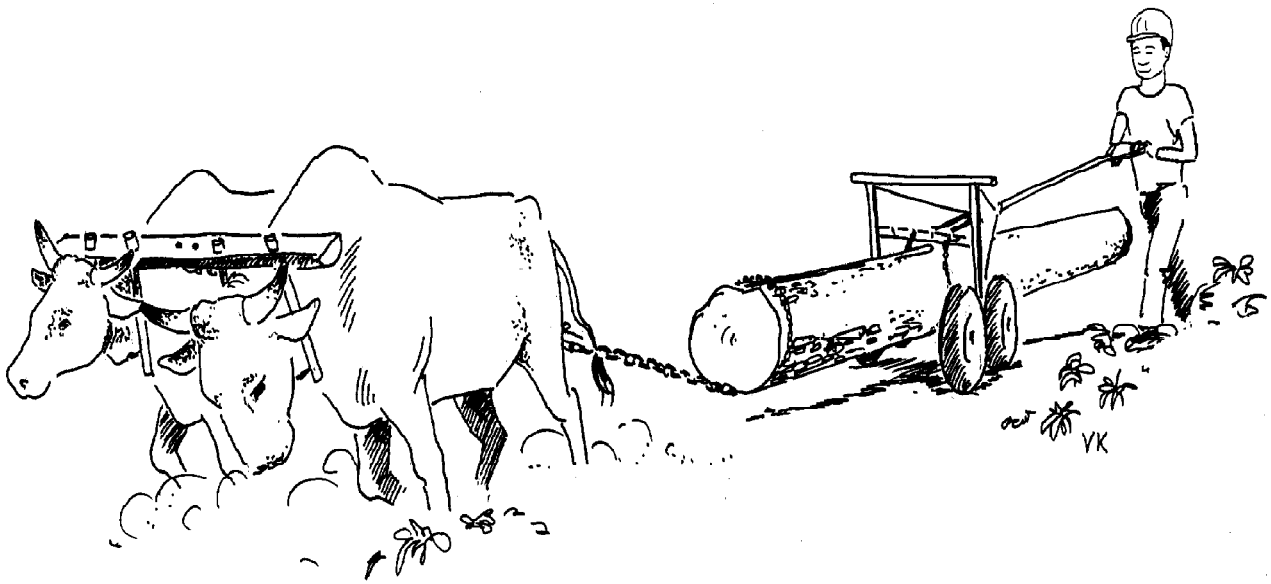
- *1* ***pulley*** *and a rope for attaching to* ***spar tree***
- *light steel cable,* ***4 - 6 mm diameter, two times length of hill***
- *4 cable locks*



Notes:

3 Draught animal sulky

Draught animals such as oxen, water buffalo, horses and donkeys can all be used in combination with the sulky to transport heavy loads over short distances. Putting a load on wheels reduces the skidding resistance, allowing animals to pull heavier loads. This is particularly useful for **large logs left at the end** of a logging operation.



How to use the sulky with oxen:

- *turn sulky around so that oxen handler can steer sulky using handle*
- *raise handle for **emergency brake***
- ***not for use downhill**, no steeper than 15 %*
- *use **well trained animals** which are accustomed to pulling wheeled loads*

Notes: