Small and simple technology cable system for logging

Fernando Vélez Escobar – Forest engineer
Gustavo Adolfo Rojas García – Forest engineer

Medellín, 2013 December 22

Summary

As a dealer for cable logging machinery, foresters came out looking for a cable system that could fit as a solution for: i) logging of isolated big trees on tropical rain forests with long distance and hilly terrain, ii) logging on small and scattered stands of planted forests in social forestry programs, and iii) thinning of young stands of broad leave planted forests with low investment in machinery and roads.

Material: skyline 3/8" cable line, endless main–haulback line 3/16" cable line, specially designed small winch for endless line, intermediate supports, tail-blocks and screwed clamp for skyline, pulleys directing and strengthening endless line, *´garrucha´* used for oil palm crops (small pulleys running hook), chain, shackle and S hooks as chocker, small simple hoist, setting up tools, land measurement instruments and Gantner Profile Calculation Program for corridor planning.

Methods: the system is a traditional design for logging cable systems with endless mainline, made out with a mixture of accessories from different commercial brands and a small and flexible winch design.

Main results: possibility of transporting logs parallel to profile surface transporting logs up to 8-12 m, up and down hill as well as all terrain logging system, and long cable system (up to 750 m).

Conclusions: system has finally been tried transporting thinned logs of a young teak planted forest as a first step, but still with low production, that should be improved by better skilled labor in the setting up and increasing the ´garruchas´ set.

Introduction

As a dealer for cable logging machinery made in Austria, foresters came out looking for a cable system that could fit as a solution for:

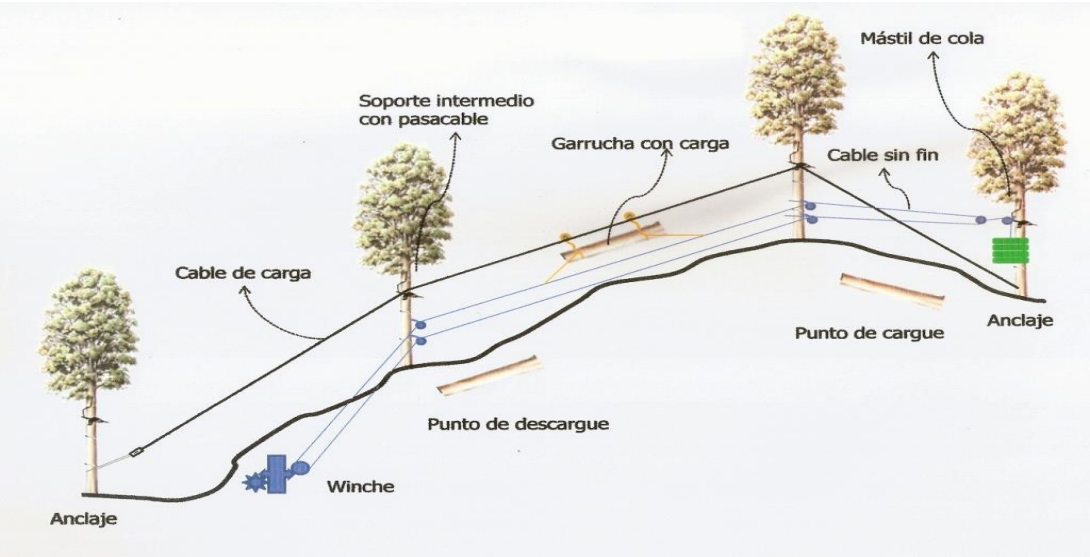
- Logging of isolated big trees on tropical rain forests, where communities need a better economic income. Characteristics were big trees, isolated ones, low volume per hectare, long distance, hilly terrain, unskilled labor and language communication difficulties.
- Logging on small and scattered stands of planted forests, under sponsored social forestry programs, looking for diverse income possibilities for small coffee growers. Characteristics were young plantations, long distance logging, mountainous terrain, down-hill logging, none knowledge of cable systems.
- Thinning in young stands of teak planted forests. Characteristics were small hills terrain, short to long distance requirements, long logs desired, low investment in machinery and roads necessary.

Objective

To develop a simple and low investment cable logging system, based upon existing accessories or under possible development equipment, to help forests owners of small business conditions (*i.e.* without formal entrepreneur administrative and financial capacity) to harvest their forests.

Materials and methods

The system is a traditional design of cable system with endless main and haul-back line.

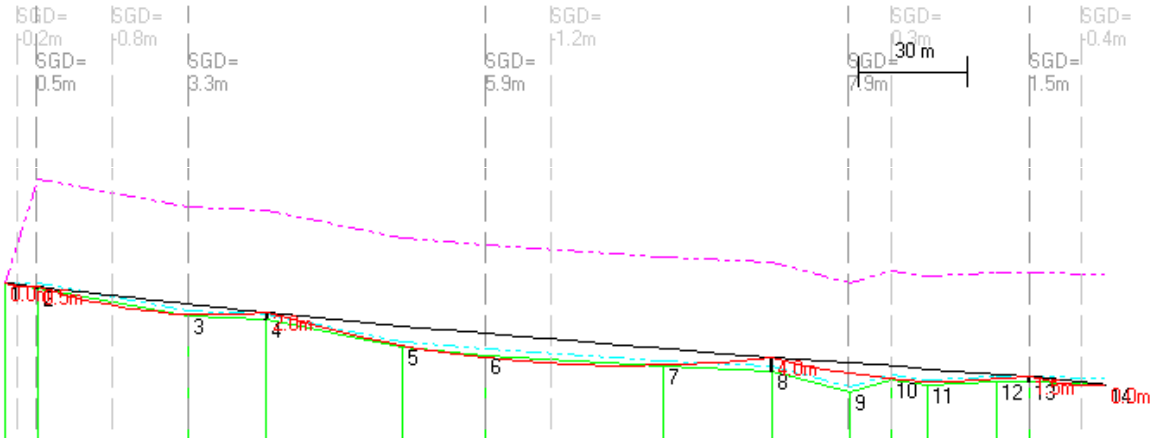


The innovative points in the system are:

- Mixture of accessories from different uses and commercial brand made.
- Design of a small and flexible winch, that was the real challenge through.

Steps

- Corridor definition: loading and unloading places and anchors.
- Profile measurement: to gather coordinates and azimuth at field with GPS, so profile measurement is then made.
- Profile calculation: made with *"Gantner - Profile Calculation Program*".



Cables

- Skyline: a 3/8" diameter cable line has been used: type 6x19, fiber or steel core, right stringed, IPS 160-180 kg/mm2, maximum braking strength 5.500 kg-f, weight 0,357-0,387 kg/ml, safety factor 3, load *vs.* working tension relation 1:5-6.
- Endless main-haul-back line: a 3/16" cable line has been used, with the following technical data: type 6x19, fiber core, right string ?, 160-180 kg/mm2, maximum braking strength 1.500 kg-f, weight 0,088 kg/ml, safety factor 5.

Operational accessories

- Skyline end anchor at tree base made with a high strength skyline eye plus shackle plus a 3 ton polyester sling with a U position.
- Skyline unloading place anchor made with a screw clamp plus a 2 eye cable sling.

- Skyline blocks used at the tail poles.
- Skyline intermediate supports at critical points in the profile, where loaded skyline would be under acceptable height.

- Endless line directing pulleys from the corridor to the winch, and then out of it, made with pulleys fixed nearby.

- Endless cable-line strength should be just enough to tied it to the power source by friction, but not too much as this will produce over strength at the cable line, and may twists the shocker. It is made with a pulley at the end of the cable line, fixed to a cable line that passes another pulley hanging from a stem, high enough to keep a load always on the air: this load is the strengthening element, and could always be moving up and down when the system is loaded or unloaded, working as a string to the endless cable line.

- Communication during operation should be made with handy equipment.

Power source

Designed and development of the winch as a power source for the endless line has been the most difficult point en the system; its characteristics should be: flexibility to arm and disarm, low weight, small size, small diesel engine required, easy to install and to operate. Many completely different versions were made until a successful one has been got.

Version 6.1. technical data: power-speed transmission are pulleys and bands, dimensions 100x75x30 cm, possible separate parts 4, net weight 50 kg, diesel engine power 6,5 HP (4,85 kW) + 35 kg weight.

Winch should be place near by the unloading place and slightly outside of the corridor, so the operator can take care of both.

Load carriage accessories

- ´G*arruchas*´: small pulleys running hooks commercially used for oil palm crops with load capacity of 90 kg each.
- Chockers made with thin chains and small a shackle or ring, tied up with small S shape hooks.
- Loads are fastened to mainline for movement with clamps, both sides, so when load moves up-hill former clamp holds it, and when load moves down-hill rear clamp holds it.


- A simple hoist made out of small pulleys and nylon string loading-unloading.

Results

Pilot trials

- *Eucalyptus saligna* young plantation: 12 years old, thinning harvest, medium size and long logs, 100-175 kg, steep terrain 35-50% slope, down-hill logging (trials made also up-hill logging), distance 450 m.


- Natural rain forest logging of timber sawn out of big trees *in situ,* timber was sawn out of big trees to 80 kg units, all terrain and down-hill profile, distance 500 m.

- *Pinus patula* clear cutting harvest, a 15 years old plantation, with about 175 m3/ha, setting up corridors every 30-50 m, distance from 100 to 250 m, from flat profile to 35% slope down-hill logging.
- Teak (*Tectona grandis*) thinning harvest: in Urabá region, Proyecto Forestal El Oasis, in a young teak planted forest, flat and small hills profile, logging long logs of 50-250 kg.


Operation

- Skyline height:
  * Minimum: the load must be over surface ground at least 0,5-1,0 m all the time; therefore skyline minimum height above ground is calculated as follows:

  Skyline minimum height = ´*Garrucha*´ length (0,50 m)
  + Chain chocker length to log (0,15-0,30 m)
  + Log diameter (0,15-0,30 cm)
  + Safety free height (0,50-1,00 m)

= 1,30-2,10 m.

* Maximum: there is no restriction for maximum height in theory; practice and special points at profile define if there are some (*e.g.* electrical lines, gorge at streams or rivers). When profile asks for height position of the skyline there will be need for branch cutting and clearing of vegetation up from the ground, this task takes a lot of time for the setting up of the corridor.

- Places for loading and unloading: as these tasks must be made by a man from the ground, it is important that:
  - Unloaded skyline height at loading place should be low enough for men to hang the little hoist and the *´garruchas´*.
  - Loaded skyline height at unloading place should be low enough for men to hang the little hoist; as this place will be needed for loading the empty *´garruchas´* to be sent back, this requires an unloaded low height too.
- Fasten a load: this is made with a clamp
- Loading time: this task could be made at the same time others loads are moving, so it does need time only for the first load (2,5-5,0 minutes); the small hoist used up to now is all right, but the improvement with a better multiple pulleys could reduce effort and time spent in it; fasten a load to the mainline by clamp is made when endless line stops for unloading a load (synchronizing both tasks gives efficiency to operation).
- Unloading time: this task needs to stop endless cable line movement, so the worker can unfasten the load´s clamps.
- Engine stop: by now to fasten and unfasten loads is only possible when endless line stops; to develop a secure and reliable technic for making this when endless line is moving would be a great improvement in time saving, so this is a remaining task to do so.
- Load capacity: net load calculation is made as follows:

  * Net whole system load = Skyline breaking load 5.500 kg-f
  * Safety factor 3
  * ➔ Working load 1.850 kg-f
  * Skyline to gross-load rate is 5-6:1
  * ➔ Gross-load 365 kg
  * *´Garruchas´* + Shocker + Clamp weight by load
  * (3,0 + 0,50 +0,75) x 2= 8,5 kg / load
  * Loads at the time 3-4 ➔ 26-34 kg
  * ➔ Net system load about 350 kg
- Endless-line speed is defined by the winch and engine: it should be between 0,5-1,0 m/second; it is possible to change winch´s pulleys to adjust it.
- Loading accessories (*´garruchas´*, shockers and clamps) must be sent to the loading place at the beginning, and then back when the whole set has been used; this takes time as loading, transporting and unloading them. For an efficient work a well-organized practice is important.
- Labor: two to four workers were used in different trials; when logs are already placed under skyline, one man can load logs and another one can unload them. Planning for the most convenient location of the corridor combined with an efficient hauling log practice, would improve efficiency of the system.

- Engine fuel consumption is about 1,0 gl/day.

Productivity and costs

This has been calculated for one pilot trial and for three additional theoretical corridors, with similar bases as the former.

Item	Quantity	Total (USD)	Quantity	Total (USD)	Quantity	Total (USD)
	Case 100-250		Caso 250-500		Caso 500-750	
Corridor data						
- Minimum working distance (m)	100		250		500	
- Maximum working distance (m)	250		500		750	
- Average distance (m)	175		375		625	
- Corridor area (ha)	1.50		2.50		2.50	
- Timber volume: (m3/ha)	50		50		50	
corredor (m3)	75		125		125	
Eficiency						
- Loads per day	89		67		52	
- Corridor time requeriment (days)	6.80		14.08		18.71	
Production						
- Production: ton / average day	9.9		8.0		6.0	
Costos						
Labor						
Subtotal		*498*		*1,031*		*1,370*
Equipment						
Winch and engine		*75*		*156*		*207*
Skyline		*49*		*173*		*342*
Endless main and haulback line		*36*		*112*		*199*
Load and transport accessories		*211*		*437*		*581*
Set up tools		*36*		*74*		*98*
Subtotal		*408*		*952*		*1,427*
- Required investment		*21,067*		*24,180*		*27,772*
Operational costs						
Subtotal		*33*		*67*		*90*
Total corridor: Col$		***938***		***2,051***		***2,887***
Col$ / ton		***14***		***18***		***26***

Main advantages

- To transport logs parallel to profile surface, without touching the soil; this makes this system a very environmentally friendly one.
- Logging of long logs (up to 8-12 m)
- Up and down hill logging, as well as all terrain logging, including all in the same corridor.
- Possibility as a long cable logging system (up to 750 m).

Conclusions

This system has been technically developed in all its parts, so it may be used for logging in forest harvesting operations for small logs.

The system has advantageous characteristics as environmentally friendly, long logs possibilities, all profile types, low investment, technically simple.

Productivity is still low, and labor use is therefore a high cost: these points may be improved through a better knowledge in planning, skill in corridor weed and branch control, small modification in accessories design, bigger quantity of *´garruchas´* set for more efficient operation, development of a fasten-unfasten clamp technic when endless line is moving, a better hoist for loading-unloading logs, an efficient haul log practice to the corridor.

Transport unit costs increases proportional to distance; to balance this higher strength skyline should be used, so whole load under it at a time could be heavier; to look for a higher volume at the corridor should also help, as this decreases fixed costs per unit.

Even though this is the smallest size of the system, by its cable lines and accessories strength capacity, systems for bigger load capacity and productivity may be possible through changing cable lines, winch and engine.