**Appendix A: Assumptions and supplementary equations**

**Table A. 1.** Assumptions for Trucks and chipper fixed cost calculation

|  |  |  |  |
| --- | --- | --- | --- |
|  | Transportation | | Processing |
| **Cost** | Single Trailer | Double Trailer | Mobile Chipper |
| Horse power (kW) | 404 | 404 | 331 |
| Trailers length (m) | 9.75 | 9.75-9.75 | - |
| Purchase Price truck/chipper ($) | 130,000 | 130,000 | 750,000 |
| Purchase price of the trailer ($) | 30,000 | 65,000 | - |
| Machine life truck (km) | 720,000 | 770,000 | - |
| Machine life trailer (km) | 1,440,000 | 1,440,000 | - |
| Chipper life (h) | - | - | 10,000 |
| Machine life (Years) | 8 | 8 | 5 |
| Trailer life years | 15 | 15 | - |
| Salvage Value truck/chipper percent of purchase (%) | 35 | 35 | 20 |
| Salvage Value trailer percent of the purchase price (%) | 25 | 25 | - |
| Interest rate (%) | 10 | 10 | 10 |
| Scheduled machine hours per year | 2,200 | 2,200 | 2,000 |

**Table A.2.** Assumptions for chipping and transport variable cost calculation

|  |  |  |  |
| --- | --- | --- | --- |
|  | Transportation | | Processing |
| Cost Item | Single Trailer | Double Trailer | Mobile Chipper |
| Annual Labor cost ($/year) | 37,770 | 37,770 | 55,550 |
| Benefits as percentage of annual salary (%) | 35 | 35 | 35 |
| Scheduled labor hours | 2200 | 2200 | 2000 |
|  |  |  |  |
| Repair and maintenance percentage of depreciation (%) | 70 | 70 | 70 |
|  |  |  |  |
| New knives ($/Knife) | - | - | 500 |
| Number of knives in the drum | - | - | 2 |
| Knife life (h) | - | - | 500 |
| Knife sharpening cost ($/Knife) | - | - | 60 |
| Hourly knife cost ($/h) | - | - | 16 |
|  |  |  |  |
| Cost Fuel Cost ($/l) | 1.06 | 1.06 | 1.06 |
| Lubricants percentage of fuel cost (%) | 7 | 7 | 36 |
|  |  |  |  |
|  |  |  |  |
| New Tyre Cost | 1,000 | 1,000 | - |
| Retreat truck tire cost | 300 | 300 | - |
| Tyre life km/tyre | 96,000 | 960,000 | - |
| Tyre life in years | 2 | 2 | - |
| Retreat tire life | 1 | 1 | - |
| Number of tires | 18 | 30 | - |
|  |  |  |  |
| Frontal area (m2) | 9.29 | 9.29 | - |
| Drag coefficient | 0.80 | 1.00 | - |
| Air density (kg/m3) | 1.22 | - |  |
| Rolling resistance coefficient paved road | 0.013 | 0.013 | - |
| Rolling resistance coefficient gravel road | 0.020 | 0.020 | - |
| Rolling resistance coefficient dirt road | 0.021 | 0.021 | - |
|  |  |  | - |
| Fuel weight (kg/l) | 0.85 | 0.85 | - |
| Truck fuel consumption high throttle (kg/kWh) | 0.24 | 0.24 | - |
| Truck fuel consumption low throttle (kg/kWh) | 0.30 | 0.30 | - |

**Fixed cost equations**

 (A1)

 (A2)

 (A3)

 (A4)

 (A5)

 (A6)

 (A7)

**Variable cost equations**

 (A8)

 (A9)

 (A10)

 (A11)

 (A12)

 (A13)

 (A14)

 (A15)

 (A16)

 (A17)

 (A18)

 (A19)

where

 salvage value of machine *m*,($).

 purchase price,($)

 salvage value percent of the purchase price of machine m (%)

 annual depreciation for machine *m*, ($)

 machine life of machine m,(Years)

 average yearly investment,($)

 interest cost of machine *m*, ($)

 interest rate of machine m, (%)

 insurance and road use, license and tax rate of machine m, (%)

 insurance and tax or road use cost for machine m, ($)

 scheduled machine hours per year of machine m (h)

 fixed costs of machine m when operating, ($/h)

 fixed costs of machine m when standing, ($/h)

 hourly labor cost of operator of machine m,($/h),

 annual salary of operator of machine m,($/h)

 benefit rate, percentage of annual salary of operator of machine m,($/h)

 scheduled labor hours per year of operator of machine m, (h)

 repair and maintenance cost, of machine m, ($/h)

 repair and maintenance percentage of depreciation, (%)

 knife cost,($/h)

 price of new chipper knife,($/knife)

 cost or knife re-sharpening,($/knife)

 number of knives

 expected knife life,(h)

 time between knife re-sharpening,(h)

 cost of supporting equipment of machine m, ($/h)

 cost of water truck of machine m, ($/h)

 cost of service truck of machine m, ($/h)

 cost of operator's truck of machine m, ($/h)

 fuel cost ($/h)

 liters per hour for chipper-forwarder

 lubricants ratio as percentage of fuel cost, (%)

 fuel price ($/l)

 variable chipping cost ($/h)

 power of truck type t, necessary to overcome rolling resistance,(kW)

 weight of truck type t, empty or loaded,(kg)

 rolling resistance coefficient based on road standard

 average speed of truck loaded or unloaded,(km/h)

 power of truck type t, necessary to overcome air resistance,(kW)

 frontal area of truck type t,(m2)

 air density,(kg/m3)

 coefficient of drag

 power necessary to overcome rolling, and air resistance based on truck engine efficiency (kW)

 truck engine efficiency (%)

 hourly truck fuel consumption (l/h)

 truck fuel consumption (kg/Kwh)

 weight of diesel (kg/l)

 hourly tyre cost,($/h)

 tyre price,($/tyre) of type n (includes the cost of 2 retreads)

 number of tyres in truck type m

 tyre expected life (including retreads) ( km)

 driven kilometers per year (km)

 productive machine hours per year for trucks (h)

 variable transportation hourly cost based on road standard r, weight *w* and speed *z,*  ($/h)