

## Key facts

- Small scale distillation unit suitable for remote areas.
- Essential oils as high value product with export potential.
- Technology to be operated by communities and cooperatives.

## What is a small-scale distillation unit?

- The small-scale essential oil distillation unit (DU) is designed to distil essential oils from aromatic plants found in remote areas in Nepal.
- It can be disassembled and carried to areas where vehicles cannot reach, especially in mountainous regions.
- Essential oils may be extracted from any medicinal and aromatic plant. Popular species in Nepal include wintergreen, mint, chamomile, citronella, eucalyptus and lemongrass. Wintergreen grows naturally and is collected from the wild while the other species are cultivated.

## History

Although aromatic plants have been collected for centuries, distillation units are relatively new to Nepal. The medicinal and aromatic plants (MAPs) sector has a considerable export potential that could enable the country to diversify exports (Jenisch and Probst, 2011). Therefore, the sector has received increased national and international attention in recent years.

## Where it works

- In Nepal, DUs can be installed in the plains or mountains. Smaller and portable DUs which can be disassembled are more suitable for mountainous regions remote from roads. In the plains or mountainous areas accessible by road, larger DUs can be installed.
- The soil and water requirements depend on the plant. A supply of clean water is necessary for the technology. Access to markets is critical. The bulk of essential oils produced in Nepal are exported because of the high prices these fetch in international markets.

## Typical adopters

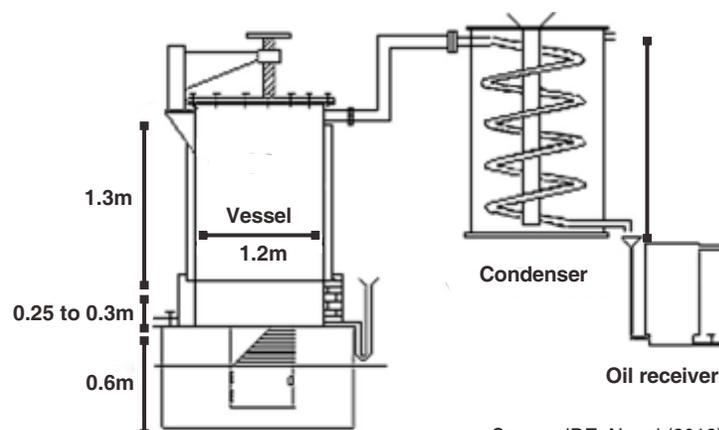
- Community ownership and operation of the distillation unit is recommended because of the high initial costs. Nepal has many community forest user groups (CFUGs) and any member of such a group may contribute plant material and earn money for it. In Nepal, more than half of aromatic plant harvesters/cultivators are women who can, thus, be empowered through the technology.
- Education is a critical step in adopting the technology and this is usually done through workshops, hands-on training and information dissemination during community meetings.
- Adopters should be trained in growing high quality aromatic

plant species as well as the sustainable harvesting of wild species and marketing.

## Technological aspect

- The DU has a capacity of between 1,500 and 2,000 litres which can hold between 200 and 500 kg of raw plant material. It uses steam distillation to extract essential oil from raw plant material.
- The DU consists of distillation tank, a condenser, a receiver, and heat source (Figure 1). Raw plant material is loaded along with about 300-500 l of water in the distillation tank (Figure 2 and 4), which is then sealed tightly and heated directly by fire. The water turns to steam, which passes over the plant material under pressure and extracts the volatile compounds.
- The steam and volatile compounds then pass through the condenser (Figures 1 and 2), comprised of a steel coil, where these are cooled to a liquid state and exit through the receiver (Figure 3).
- At this stage, the liquid contains hydrosol (primarily water with a small amount of essential oil) and the essential oil which can be easily separated due to differences in density (Douglas, Heyes, and Smallfield, 2005).
- The oil is filtered and stored in an aluminum or stainless steel container (Figure 3). The hydrosol is recycled by adding it to the next batch of plant material in the distillation unit.
- On average, it takes 4 to 8 hours to process one batch of plant material. This includes approximately 20 to 30 minutes

Figure 1. Schematic drawing of a small-scale distillation unit



Source: iDE, Nepal (2012)

to load the tank with raw material, 1.5 hours for the water to boil, and 3-6 hours of processing. The processing time depends on the type of plant; chamomile takes up to 8 hours, but most other plants need 4 hours. With regular maintenance, the DU can be operated for at least 10 years (Johnson, 2013).

- Between 45 and 300 production cycles are possible per year. This depends on the type of raw plant material. If only chamomile is used, there will be about 45 production cycles in a year; if a combination of chamomile, lemon grass, and mint is used, about 300 production cycles can be processed annually. Table 1 lists the most popular plants and the time of year during which these are processed.

Figure 2. Parts of a distillation unit



Figure 3. Receiver, filter, and storage container (left); hydrosol and essential oil in the receiver (right)

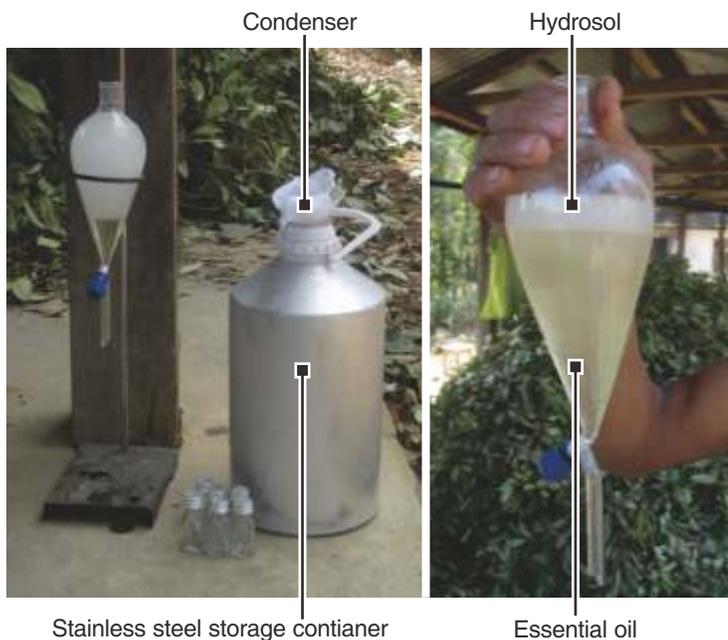


Figure 4. Loading wintergreen leaves into the DU



**Table 1. Popular aromatic plants and time of processing**

Plant / month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Chamomile												
Citronella												
Curry Leaf												
Eucalyptus												
Lemon grass												
Mint												
Wintergreen												

Source: Johnson (2013)

## Economic aspects

The economics of the technology can be viewed (1) from the point of view of operating the DU as an enterprise and (2) from that of individual contributors (cultivators and gatherers) to the DU.

1) **As an enterprise**, the investment cost for a small-scale DU that can be capitalized by a cooperative is US\$ 4,651 (NPR 410,000) in 2013, broken down as cost of the unit at US\$ 1,815 (NPR 160,000) and the cost of transportation, custom duties, shade construction, and installation at US\$ 2,836 (NPR 250,000). Since then, the price of a DU has increased to US\$ 3,403 (NPR 300,000), which brings the total cost to US\$ 6,240 (NPR 550,000).

- An example of the economic results of the use of one DU is shown in the following table with the gross margin calculated from a crop combination of chamomile, eucalyptus and wintergreen.
- Oil yields extracted can vary in function of the quality of raw material and market prices can fluctuate greatly, even during the same season. However, the figures shown in the table give an idea of achievable results during the production year.

2) **Individual contributors** are either cultivators or gatherers of aromatic plants as raw material for the DU. Cultivators usually grow chamomile, citronella, lemon grass, and mint, and are paid per kg of essential oil produced. Gatherers usually collect wild plant species, including curry leaf, eucalyptus, and wintergreen, and are paid per kg of raw material collected.

- For the cultivation of aromatic plants, the investment cost for individual users is on average US\$ 14.75 (NPR 1,300) per year for an average plot size of 3,460 m<sup>2</sup> (0.346 ha), which is used to pay for seeds and fertilizer during the annual growing season (Johnson, 2013). These cultivators were growing chamomile, mint, lemon grass, and citronella.
- If harvesters do not have their own means of transportation, local tractors are available for rent for US\$ 3.40 (NPR 300) per day (Johnson, 2013). The number of days of tractor rental depends on the amount of plant material and the number of harvests. Based on the average annual amount of plant material (over 2,000 kg) and the harvesting schedule, it is reasonable to expect 8 days of tractor rental.
- The time farmers spend will depend on the amount of land they cultivate. It is estimated that 30 hours are spent planting seeds, weeding, watering the fields and harvesting for one production cycle on a plot size of 3,460 m<sup>2</sup> (Johnson, 2013).

	A	B	C	D	E	F	G	H
	Production cycles per year	Amount of oil distilled per production cycle (kg)	Selling price (US\$/kg) <sup>1</sup>	Gross value per production cycle (US\$)	Wage of DU technician per production cycle (US\$) <sup>1</sup>	Other variable costs of the DU <sup>1</sup> (US\$)	Amount paid to contributors (US\$) <sup>1</sup>	Total variable costs per year (US\$) <sup>1</sup>
<b>Chamomile*</b>	45	0.5	204.21	4 594.73	11.35	3.97	81.68	4 365.18
<b>Citronella</b>	56	1.2	13.61	914.59	11.35	3.97	5.44	1 162.78
<b>Eucalyptus*</b>	10	1.5	11.34	170.10	11.35	3.97	4.54	198.56
<b>Lemongrass</b>	230	1.2	28.36	7 827.36	11.35	3.97	11.34	6 132.72
<b>Mint</b>	60	1.2	79.41	5 717.52	11.35	3.97	31.76	2 825.04
<b>Wintergreen*</b>	110	1.5	34.04	5 616.60	11.35	3.97	16.34	3 482.60
* Sub total including chamomile, eucalyptus, and wintergreen				10 381.43				8 046.34
* Exemplary DU gross margin including chamomile, eucalyptus, and wintergreen				2 335.09				

Notes: <sup>1</sup>Includes marketing costs, overhead, and maintenance. Exchange rate: NPR 100 = US\$ 1,13452, OANDA currency converter of 31.03.2013, www.oanda.com.

Source: iDE, Nepal (2012); Johnson (2013)

Average plot size (ha)	Average expenses (US\$/plot/year)	Total harvest (kg plot/year)	Transportation costs (US\$/day)	Trips needed	Total transportation costs (US\$/plot/year)	Total production costs (US\$/plot/year)
0.346	14.75	2 231	3.40	8	27.2	41.95

- Gatherers of aromatic plants do so in addition to other household activities and the household income depends on how many times they gather, how many hours they spend gathering and their proficiency in collecting the plant material. Wintergreen gatherers (Figure 5) make between US\$ 17.02 and US\$ 56.52 (NPR 1,500-5,000), with an average of US\$ 30.36 (NPR 2,700), per year. They were paid US\$ 0.08 (NPR 7) per kg of raw material collected in 2013, although that price may fluctuate from year to year (Johnson, 2013).
- It is estimated that about 40 hours are spent in collecting 500 kg of plant material (Johnson, 2013).

Figure 5. Gatherers bringing wintergreen to the DU



Photo: C. Johnson

## Environmental aspects

- The DU uses about 0.5 m<sup>3</sup> of water per production cycle.
- About 2,560 kWh of energy from biomass are used per production cycle (calculation based on Biomass Energy Center, 2011).
- The DU itself is imported from India. Once installed, it operates relatively independent of outside inputs: 95-100 per cent of water, fuel and plant material are obtained from within the community. The remaining 5 per cent are seeds, fertilizer, and pesticides, obtained from outside the community.
- About 80 per cent of inputs needed to operate one unit for one production cycle are by-products of other farming activities; this includes water from previous production cycles and plant by-products as fuel for the DU.

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## Social aspects

- Based on the processing capacity of the small-scale DU described here, an estimated number of 50-80 local people can contribute plant material by the unit. Women comprise 60 per cent of adopters.
- A study conducted in 2013 revealed that farmers used, on average, 3,460 m<sup>2</sup> of land to grow aromatic plants for essential oils production (Johnson, 2013). However, land ownership is not a prerequisite as plant material can be collected from the wild (e.g. wintergreen).

## Issues for replication

- In order to be exported, essential oils need to be consistently high-quality. Additionally, it may be challenging to find buyers in Europe and North America where demand for essential oils is high.
- A quality test in a professional laboratory can help. Certification such as for meeting organic and fair trade norms, can also be a worthwhile investment because certified oils fetch higher prices on the international market.
- Operators of the technology should receive adequate training in order to operate and maintain the DU.

## Contacts

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## References

Available at: <http://www.satnetasia.org/database>

## Useful links

- New Distillation Units for Sustainable Management and Processing of NTFP Project, Dolakha by Khilendra Gurung. <http://www.scribd.com/doc/9668446/New-Distillation-Units-for-Sustainable-Management-and-Processing-of-NTFP-Project-Dolakha>
- Essential Oils Sector Study in Nepal: A Detailed Study of Anthopogon, Juniper and Wintergreen Essential Oils by Khilendra Gurung. <http://www.scribd.com/doc/39087670/Sector-Study-of-Essential-Oils-in-Nepal-GTZ-Nepal>
- Herbs, spices and essential oils: post-harvest operations in developing countries by M. Douglas, J. Heyes, and B. Smallfield. [http://www.fao.org/inpho\\_archive/content/documents/vlibrary/ad420e/AD420E00.htm](http://www.fao.org/inpho_archive/content/documents/vlibrary/ad420e/AD420E00.htm)
- Manufacturer of the DUs is Swaraj Herbal Plants Pvt. Ltd. <http://www.swarajindia.com/enquiry.html#contact>