

Small-scale Distillation Unit

Key facts

- Technology to be operated by communities and cooperatives
- Small scale distillation unit suitable for remote areas.
- High value, low volume product with export potential.

What it is

The small-scale essential oil distillation unit (DU) is designed to distill essential oils from aromatic plants in remote areas. It can be disassembled into parts and carried to areas where vehicles cannot reach, which is especially useful in hilly and mountainous regions.



Loading wintergreen leaves into the DU. Photo: C. Johnson.

1



Gatherers bringing wintergreen to the DU. Photo: C. Johnson.

2

History

Although the collection of aromatic plants has been happening for centuries, distillation units are relatively new to Nepal. The medicinal and aromatic plants sector has a significant export potential that would enable the country to diversify its exports. Furthermore, the sector has a high socioeconomic impact in Nepal (Jenisch & Probst, 2011). Because of this, essential oil production has received support from international and national non-governmental organizations in the past years.

Context

In Nepal, DUs can be adopted in the flatlands, hills, or mountains. Smaller DUs which can be disassembled into pieces are more suitable for hill and mountain regions where transportation is not available. Essential oil may be extracted from any medicinal and aromatic plant. Popular species in Nepal include wintergreen, mint, chamomile, citronella, eucalyptus and lemongrass. Wintergreen is growing in the wild and other are cultivated in agriculture land or in wasteland. Necessary soil conditions and water needs will depend on the type of plant grown. Access to markets to sell essential oil is critical. The majority of essential oils are exported because high prices can be obtained in international markets. A supply of clean water is also necessary to operate the technology.

Typical adopters

Typically, the distillation unit is owned and operated by a community, in Nepal by so-called community forest user groups (CFUGs) because of high initial costs that require a common investment. Anyone belonging to the group may contribute plant material and earn money for it. In Nepal, more than half of the plant harvesters/cultivators are women. Most importantly, an adopter should be trained on the opportunities available, on how to grow aromatic plant species, and on the sustainable harvest of wild species. The harvesters/cultivators should be trained on the importance of quality production and market aspects of their products. Education is a critical step in adopting the technology and this is usually done through workshops and announcements at community meetings.

How it works

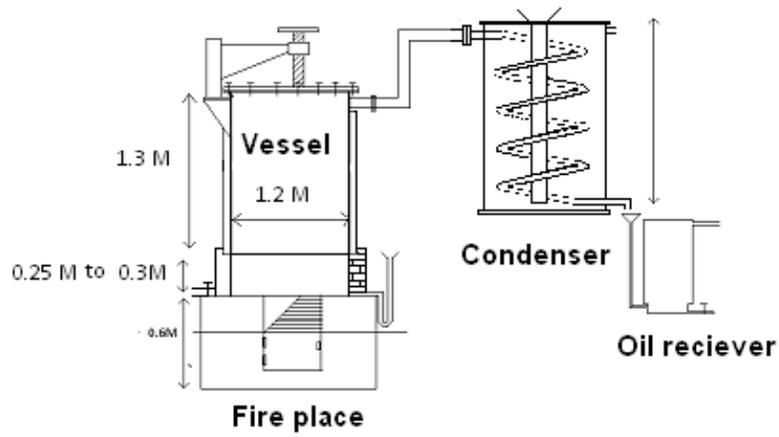
The production unit described here is one small scale essential oil distillation unit (DU) with the capacity of 1500-2000 liters which can hold between 200-500 kg of raw plant material.

The DU uses steam distillation to extract essential oil from raw plant material. The technology consists of the distillation tank, a condenser, a receiver, and a heat source. Raw plant material and about 300- 500 l of water are loaded into the distillation tank, which is then sealed tightly and directly heated by fire. As the water heats up, it turns to steam, which passes over the plant material under pressure and extracts volatile compounds. The steam and volatile compounds then

pass through the condenser, comprised of a steel coil, where they cool to a liquid state. The resulting liquid exits through the receiver. At this point, the liquid contains hydrosol (primarily water with a small amount of essential oil) and the essential oil. The hydrosol is recycled to distillation unit. Due to differences in density, they can easily be separated (Douglas, Heyes, & Smallfield, 2005). The oil is filtered and then stored in an aluminium or stainless steel container. On average, it takes 4-8 hours to process one batch of plant material. This includes approximately 20-30 minutes to load the tank with raw material, 1.5 hours for the water to boil, 3-8 hours of processing time. 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, such a DU can be operated for at least 10 years (Johnson, 2013).



Photos: C. Johnson



Source: (iDE Nepal, 2012)



Photos: C. Johnson

- Between 45-300 production cycles can be done per year. This depends on the varieties of crops which are processed. If only chamomile is grown, there will be about 45 production cycles; if a combination of chamomile, lemongrass, and mint is grown, there would be closer to 200 production cycles. A table of the most popular plants and the time of year during which they are processed is listed below.

month/ plant	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Chamomile												
Citronella												
Curry Leaf												
Eucalyptus												
Lemongrass												
Mint												
Wintergreen												

Source: (Johnson, 2013)

Economic aspects

There are two economic points of view to consider: the one of the DU as an enterprise and the one of the individual contributors (cultivators and gatherers) to the DU.

DU as an enterprise

Investment cost for a small-scale DU paid by the cooperative is US\$ 3403 (NPR 300,000) for the DU itself, plus other costs including transportation, custom fees, shade construction, and instillation at US\$ 2,836 (NPR 250,000), totaling US\$ 6,240 (NPR 550,000).

Example of the economic results which can be expected from one DU. The gross margin is calculated for a crop combination of chamomile, eucalyptus and wintergreen.

	A	B	C	D	E	F	G	H
	Production cycles per year	Amount of oil distilled per production cycle (kg)	Selling price (US\$/kg) ¹	Gross value per production cycle (US\$)	Wage of DU technician per production cycle (US\$) ¹	Other variable costs of the DU ¹ (US\$)	Amount paid to contributors (US\$) ¹	Total variable costs per year (US\$) ¹
Chamomile*	45	0.5	204.21	4594.73	11.35	3.97	81.68	4365.18
Citronella	56	1.2	13.61	914.59	11.35	3.97	5.44	1162.78
Eucalyptus*	10	1.5	11.34	170.10	11.35	3.97	4.54	198.56
Lemongrass	230	1.2	28.36	7827.36	11.35	3.97	11.34	6132.72
Mint	60	1.2	79.41	5717.52	11.35	3.97	31.76	2825.04
Wintergreen*	110	1.5	34.04	5616.60	11.35	3.97	16.34	3482.60
* Sub-total including chamomile, eucalyptus, and wintergreen				10381.43	3	4		8046.34
* Exemplary DU gross margin including chamomile, eucalyptus, and wintergreen				2335.09	5	6	7	8

Notes: ¹Includes marketing costs, overhead, and maintenance. Exchange rate: 100 NPR = 1.13452 US\$, OANDA currency converter of 31.03.2013, www.oanda.com. Source: (iDE Nepal, 2012; Johnson, 2013)

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.

Individual contributors

Contributors either cultivate or gather aromatic plants. Cultivated plants include chamomile, citronella, lemongrass, and mint. In general, cultivators are paid per kg of essential oil produced after processing. Gathering is done for plant species which grow wildly. These include curry leaf, eucalyptus, and wintergreen. The wintergreen gatherers are paid per kg of raw material collected.

Cultivation of aromatic plants

- Investment cost for individual users is on average US\$ 14.75 (NPR 1300) per year for an average plot size of 3460 m² (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, lemongrass, and citronella.
- If harvesters do not have their own means of transportation, local tractors are generally 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 done. Based on the average annual amount of plant material (over 2000 kg) and the harvesting schedule, it is reasonable to expect that 8 days of tractor rental are needed.

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	2231	3.40	8	27.2	41.95

- The amount of time farmers spend will depend on the amount of land which 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 3460 m² (Johnson, 2013).

Gathering of aromatic plants

- Gathering is done in addition to other household activities, and the amount each household earns depends on how many times per year they choose to gather, how many hours they spend gathering, and how proficient they are at collecting the plant material. Accordingly, wintergreen gatherers make between US\$ 17.02 and US\$ 56.52 (NPR

1500-5000), with an average of US\$ 30.36 (NPR 2700), per year. They are paid US\$ 0.08 (NPR 8) per kg of raw material collected (Johnson, 2013).

- It is estimated that about 40 hours are spent collecting 500 kg of plant material (Johnson, 2013).

Environmental aspects

- The DU uses about 0.5 m³ of water per production cycle.
- About 2560 kWh of energy from biomass are used per production style (calculation based on Biomass Energy Center, 2011)
- The DU itself is manufactured outside the community and imported from India. Once installed, the DU operates relatively independent from outside inputs: 95-100% of water, fuel, and plant material come from within the community. The remaining 5% are seeds, fertilizer, and pesticides, which come from outside the community.
- About 80% of inputs needed to operate one unit during one production cycle are by-products of other farming activities; this includes using water from previous production cycles and plant by-products as fuel to heat the DU

Social aspects

Based on the processing capacity of the small-scale DU considered here, an estimated number of 50-80 people from the community may contribute plant material to the unit. Women make up 60% of adopters. A study conducted in 2013 revealed that farmers used, on average, 3460 m² of land to grow aromatic plants for essential oils production (Johnson, 2013). However, owning land is not a prerequisite to contribute to the DU since collection from the wild (for example, wintergreen) can be done.

Possible issues for replication

If essential oils are going to be exported, they 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). Getting the quality tested in a professional laboratory can help. Certification such as organic and fair trade can also be a worthwhile investment because certified oils receive higher

prices on the international market. Operators of the technology should receive adequate training in order to operate and maintain the DU.

Composite sustainability indicator

Contacts

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- Jenisch, T., and Probst, T. (2011). *Medicinal and Aromatic Plants: Poverty Impact Assessment (PIA) of proposed Trade Support Measures in Nepal's Medicinal and Aromatic Plants Sector*. Eschborn, Germany.
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- Johnson, C. (2013). Sustainability Assessment of an Essential Oil Distillation Unit in Nepal. Master Thesis, University of Hohenheim, Stuttgart, Germany.

Useful links

- New Distillation Units for Sustainable Management and Processing of NTFP Project, Dolakha by Khilendra Gurung, available online: <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, available online: <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, B. Smallfield, available online: 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>