# Morphometric studies of *Terminalia bellirica* from Sacred Groves of Sangmeshwar Tahasil

We are four students from ISTOM, French engineering school in international agro-development. After graduate, we'll be form to participate, make or manage some projects in developing countries. We are specialized in agronomy from fields to commercialization. To fulfill our formation we have chosen to do a training ship on the fields.

This report has been made in cooperation with AERF and their staff of Sadavali field station.


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Photo 2 Shamtaram Jaigude

Photo 1 : Suresh Deshmukh

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# EXECUTIVE SUMMARY

"Western Ghats region of India is a biodiversity hotspot with highly endangered and endemic species of fauna and flora." (Archana, Jayant, & Rahul). The region harbors varied types of forest and biodiversity but today Western Ghats are threaten by several human activities like mining, urbanization, agriculture…

The present study was carried out in Ratnagiri district of Maharashtra state, India, located in the Northern part of the Western Ghats, and have concerned particularly sacred groves. Sacred groves are fragmented areas the more they are reduced the more they are vulnerable. Modifications of sacred groves will implicate an ecological and environnemental impact, (Bennett, 2003).

The Applied Environmental Research Foundation (AERF) is a non-government organisation (NGO) which is working on environnemental projects. AERF is the only organization that has been involved in documenting sacred groves and shifting agriculture practices from the region (Archana, Jayant, & Gokahle, K, 2002).

Today deforestation is the first threat for forests. With the use of forests' resources we can save forests. AERF's project is a good example. Indeed villagers cut trees to increase their cultures areas and to sell trees as fuel woods. So to stop these practices we have to valorize forests. *Terminalia bellerica*'s fruits could be commercialized and so these trees become more interesting for villagers. If they get involved in this work forests can be saved and villagers could increase their incomes.

# INTRODUCTION

Sacred groves are small forest patches; UNESCO defined them as an area of natural vegetation preserved through local taboos and sanctions and are a sign of spiritual and ecological values[1]. For others, sacred groves are a biological heritage and a system that has helped to preserve the representative resources existing in the surrounding regions for many generations. All meanings of sacred groves show us a co-existence of cultural and biological diversity.

Sacred groves in India are examples of such socio cultural faith system that has developed mainly for conservation of valuable biodiversity. There're also huge place of medicinal trees and are providing refuge to variety of insects, mammals and birds, like Malabar hornbills.

But sacred groves are under constant threats due to illegal felling; encroachment for agriculture and expansion of hamlets; uncontrolled free grazing; clearing the groves for establishing social forestry plantations, opening up for canal, roads and barrage or tourism. In addition, the cutting of sacred groves' trees brings money as fuel wood or timber. This money should be directly by farmers or used for renovation of existing cave temple (that's the case of Kudavali's sacred groves where ancient old growth trees have been cut to raise funds for temple renovation)

One of trees present in sacred groves is the *Terminalia bellerica.* It can be considerate as a flagship species (Yasuo, Diogo, Douglas, & Godbole, 2012), so that, protect this tree seem to be the best way to preserve sacred groves. This tree can be used in a many sectors: food, fuel, fodder, dyestuff, timber, cosmetics (Laboratories, 2012), etc…Besides *T. bellerica* has medicinal virtues: His fruits can look after eye diseases, diarrheas and have laxatives astringent, pungent effects and antihypertensive effect (Arif-Ullah & Anwarul, 2008).

Applied Environmental Research Foundation (AERF), try to protect the Sacred Groves. The best way to do it in a long-term is to involve local population. That's why the first step of this project was to provide alternative livelihood strategies for natural resource dependent communities.

[1] (Godbole & Sarnaik, 2004)

It has already done with Pukka inc. which assure that *T. bellerica*'s fruits could be marketable for medicine issues (powder of *T. bellerica*'s fruits). If the benefits from this activity can compensate (in cash and kind as well as through alternative off-farm income generating opportunities) local communities for the no access of resources inside the sacred groves, the safety of sacred groves will be guarantee. Villagers will stop cutting trees for firewood if they earn more money participating at the collect's fruits.

For the success of this project, AERF must know the *T. bellerica*'s fruits production. That's why we have to sample *T. bellerica* in the sacred groves.

**Study Area**

The study area is situated in the Northern Western Ghats, Ratnagiri district, Sangameshwar Tahasil. It comprises 287 sacred groves (Godbole & Sarnaik, 2001) but we only sample 22 of these distributed in 18 villages.


Figure 1 : India's map

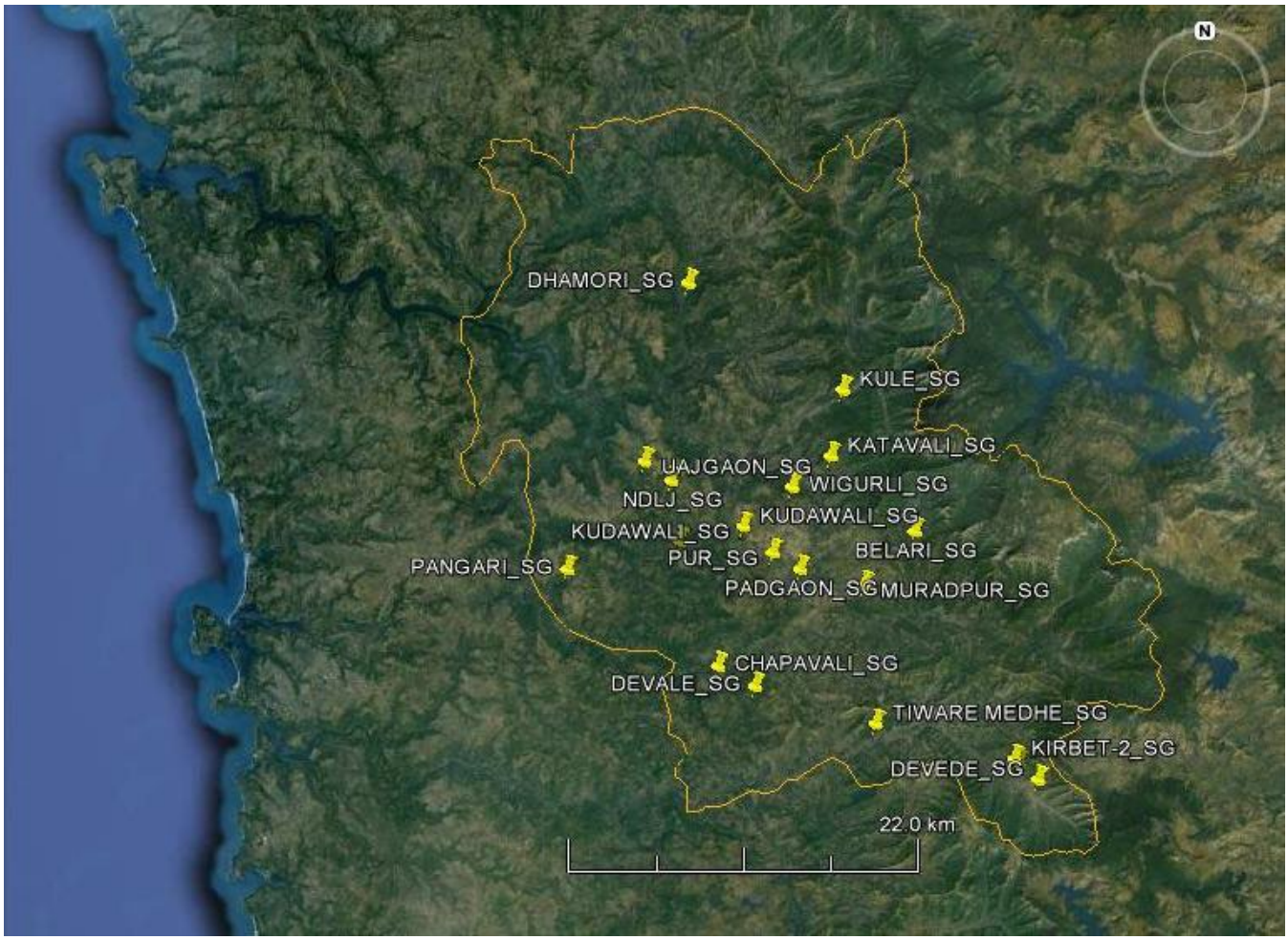
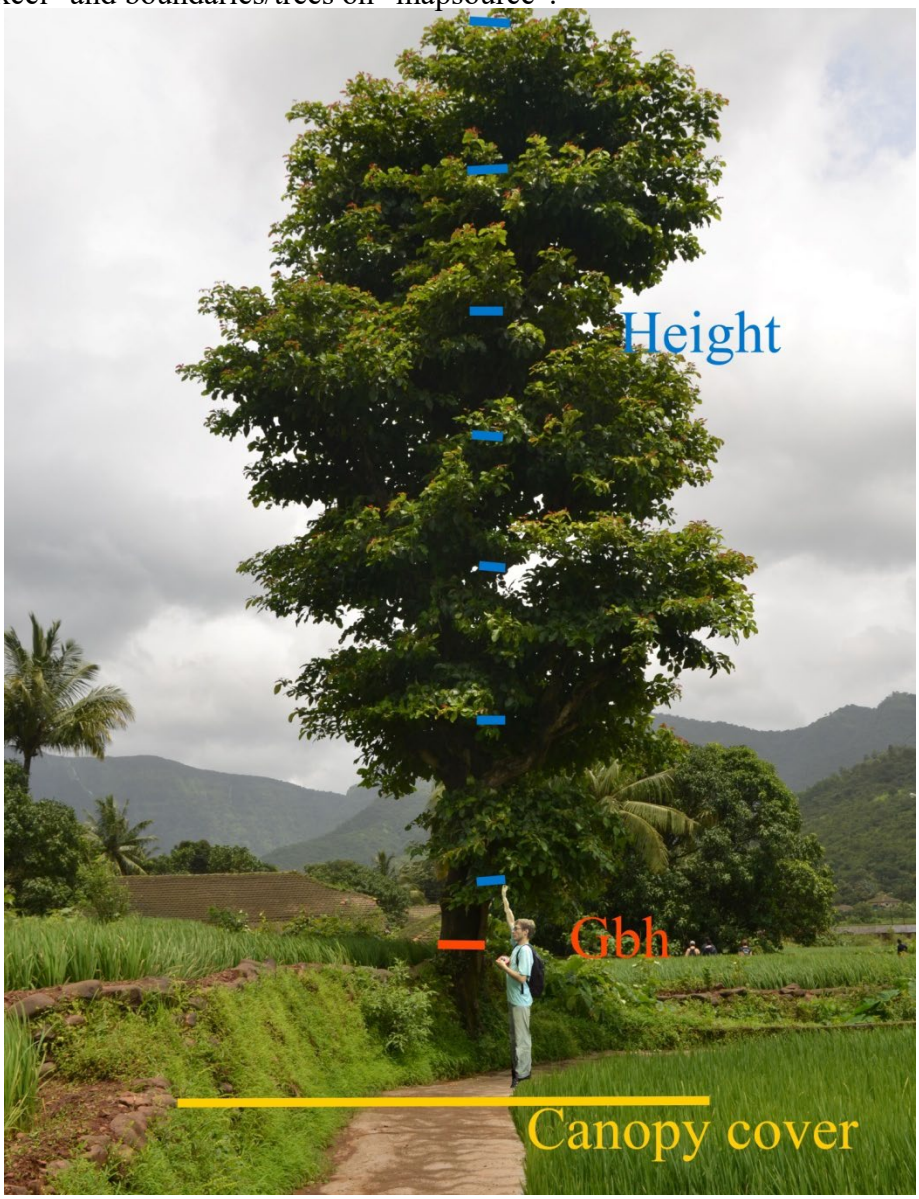



**Figure 2 : Sangameshwar Tahasil of Maharashtra, and all study areas.**

# I. METHODOLOGY

The current study was undertaken during one month around Sadavali in Ratnagri district in the Western Ghats.

This sampling consists to spot *T. bellerica* present in sacred groves and mark out with a GPS then sacred groves' boundaries are marked. Each spotting trees are measuring; The GBH (girth at breast height) in centimeters with a tape, measurements are made approximately 4.5 feet above the ground (breast height) in order to give an average diameter (Bonham, 1989). Canopy cover is also taken with a tape, measure have to correspond to the distance enter the two extremities of branches. Lastly, total tree height is measured from the ground to the top of the tree without tool, we guessing height with a team mate as scale. Then fields work, all of data are compiled on the software "excel" and boundaries/trees on "mapsource".

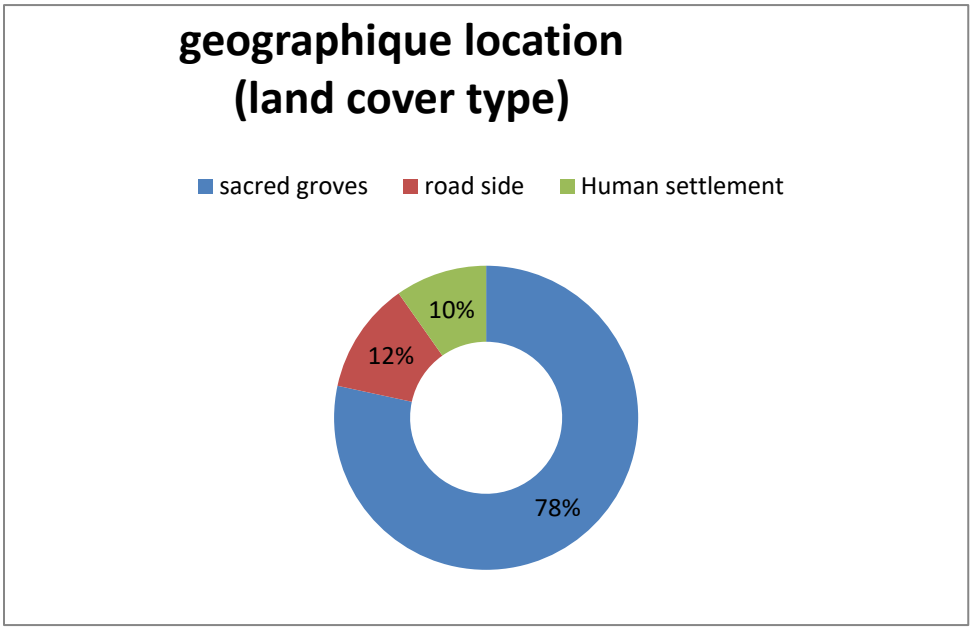


**Sampling effort:**

During the period of 22 days of field work, we sampled 673 trees of Terminalia bellirica from 22 places. 78% of sampling was belongs to the Sacred groves while 12% and 10% from road side as well as from human settlements respectively.

| Habitat | Number of sites | sample size |
|---|---|---|
| sacred groves | 22 | 482 |
| road side | 2 | 73 |
| Human settlement | 2 | 60 |
| Total | 27 | 615 |

Table 1 : Sampling effort




Graph 1 : sampling effort

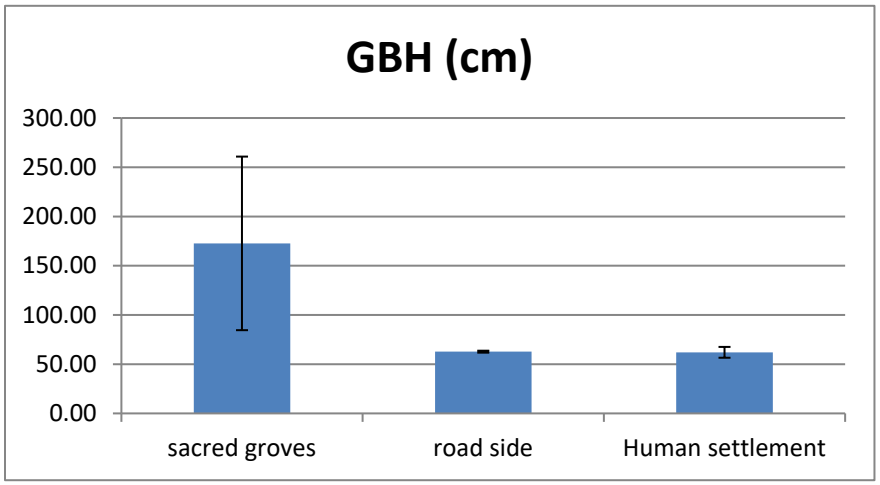
# II. OBSERVATIONS

## A. Morphological Status of Terminalia bellirica in different areas:

### i. Tree Girth at Breast Height in cm

| Land cover type | GBH (cm) | STDEV |
|---|---|---|
| sacred groves | 172.67 | 88.15 |
| road side | 62.70 | 0.99 |
| Human settlement | 62.03 | 5.50 |

Table 2 : GBH in different land cover type



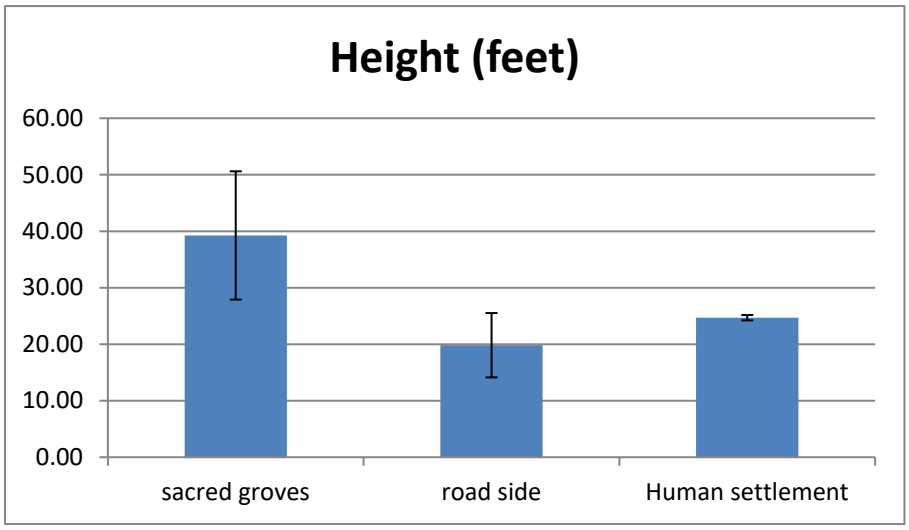

Graph 2 : GBH in different land cover type

As show on the graph, GBH is in average bigger in sacred groves than others habitats. But STDEV on sacred groves are also very important (88.5)

### ii. Tree height in feet:

| Land cover type | height (feet) | STDEV |
|---|---|---|
| sacred groves | 39.26 | 11.35 |
| road side | 19.83 | 5.69 |
| Human settlement | 24.69 | 0.47 |

Table 3 : Height in different land cover type




Graph 3 : Height in different land cover type

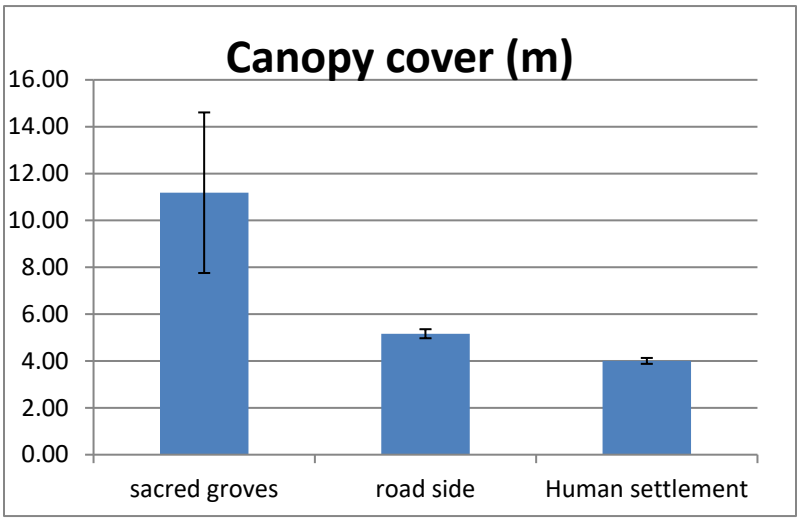
As for the GBH, heights of sacred groves' trees are superior to trees which lived in other habitats.

About results of road side, trees are smallest but with a quite important STDVE.

### iii. Canopy cover in meter:

| Land cover type | canopy cover (m) | STDEV |
|---|---|---|
| sacred groves | 11.18 | 3.43 |
| road side | 5.16 | 0.19 |
| Human settlement | 4.00 | 0.13 |

Table 4 : Canopy cover in different land cover type




Graph 4 : Canopy cover in different land cover type

As previous measures, canopy cover in sacred groves are wider than others habitants, with an important STDEV too. About canopy cover, human settlement's trees are least.

## B. Characterization of sacred groves

Table 5 : Areas and densities of sacred groves.

| Sacred groves' name | area (ha) | density (trees/ha) |
|---|---|---|
| Pangari | 3.59 | 1.12 |
| katavli | 8.28 | 1.33 |
| Kudawali | 4.73 | 2.11 |
| Chapavali | 7.93 | 4.16 |
| Belari | 3.84 | 5.74 |
| Uajgoan-2 | 0.68 | 5.85 |
| Muradpur | 0.53 | 9.41 |
| Kule | 1.00 | 11.00 |
| Vighravali | 1.30 | 15.42 |

| Sacred groves' name | area (ha) | density (trees/ha) |
|---|---|---|
| Devede | 1.67 | 16.74 |
| Devale | 1.92 | 19.28 |
| Padgaon | 1.98 | 24.19 |
| Tiware Medhe | 1.58 | 35.37 |
| Sangave | 1.32 | 43.28 |
| Nandalj | 0.48 | 50.11 |
| **Average** | **2.72** | **16.34** |
| **Standard deviation** | **2.51** | **15.60** |

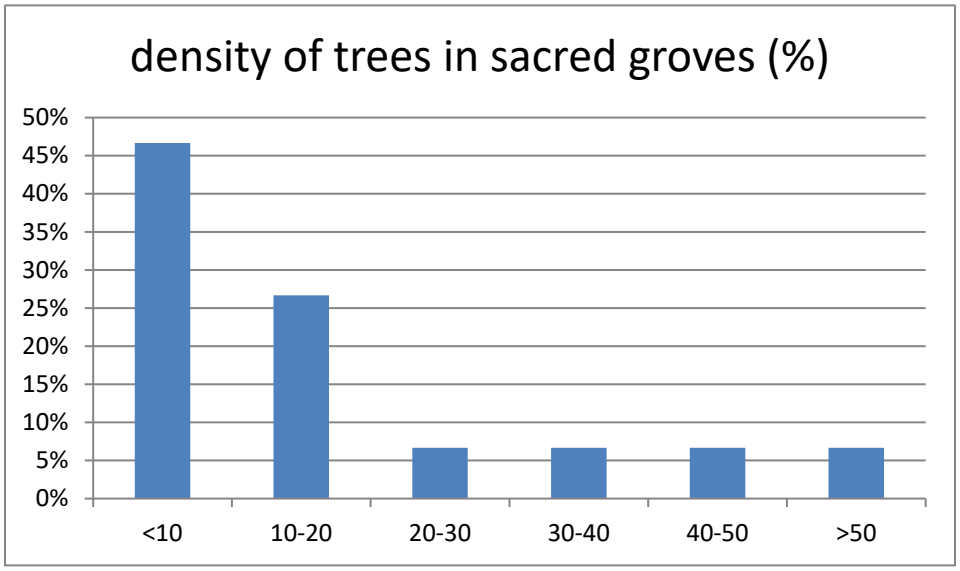
Boundaries and number of trees have permitted to characterize sacred groves. However, all the boundaries aren't yet finished that is why only fifteen sacred groves are only available this table. This section will only provide information coming from these sacred groves.

Because of the huge heterogenic areas of the sacred groves, from 0.48ha for Nandalj to 15ha for Vighravali (Table 6), the densities were calculated. For a better understanding of the situation, the different densities are gathered in intervals of 10 trees per hectare (table 5 and graphic 5).

As we can see, most of the sacred groves, more than 45%, have a density below 10 tree/ha. It's the case for Pangari, Katavli, Kudawali, Chapavali, Belari, Uajgoan-2 and Muradpur. According to these results, we could say that the most representative sacred grove have a density below 10 tree/ha.

| density (tree/ha) | <10 | 10-20 | 20-30 | 30-40 | 40-50 | >50 |
|---|---|---|---|---|---|---|
| % of sacred groves | 46.67% | 26.67% | 6.67% | 6.67% | 6.67% | 6.67% |
| number of sacred groves | 7 | 4 | 1 | 1 | 1 | 1 |
| names | Pangari<br>Katavli<br>Kudawali<br>Chapavali<br>Belari<br>Uajgoan-2<br>Muradpur | Kule<br>Vighravali<br>Devede<br>Devale | Padgaon | Tiware Medhe | Sangave | Nandalj |

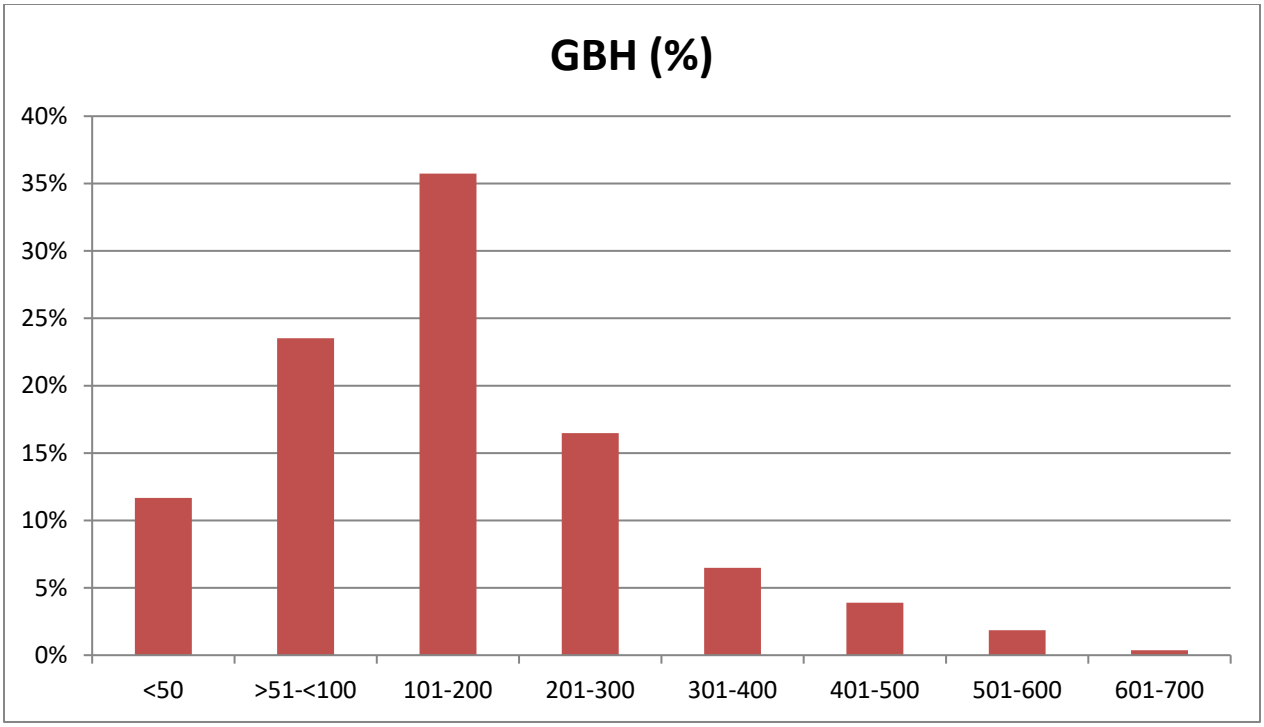
Table 6 : density in tree/ha of the different sacred groves




Graph 5 : percentage of sacred groves for each categories of density

# III. RESULTS AND DISCUSSIONS

## A. Morphological Status of Terminalia bellirica in sacred groves

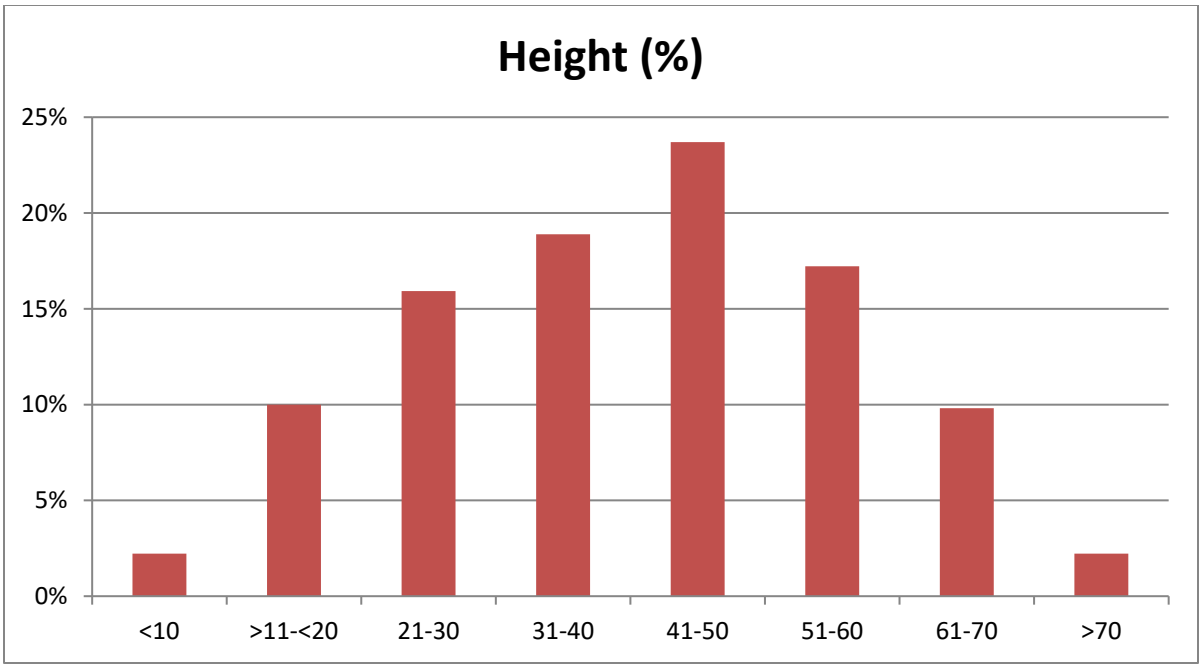



Graph 6 : GBH of trees' repartition in sacred groves

| GBH | <50 | >51-<100 | 101-200 | 201-300 | 301-400 | 401-500 | 501-600 | 601-700 |
|---|---|---|---|---|---|---|---|---|
| nbre | 63 | 127 | 193 | 89 | 35 | 21 | 10 | 2 |
| % | 11.67% | 23.52% | 35.74% | 16.48% | 6.48% | 3.89% | 1.85% | 0.37% |

Table 7 : GBH of trees' repartition in sacred groves

The majority of trees' GBH in sacred groves are between 101 and 200 centimeters (more or less 40% population of the total sampling effort). That's good because trees inferior to 50 are too young to be exploited and trees superior to 300 are too old to have a great production

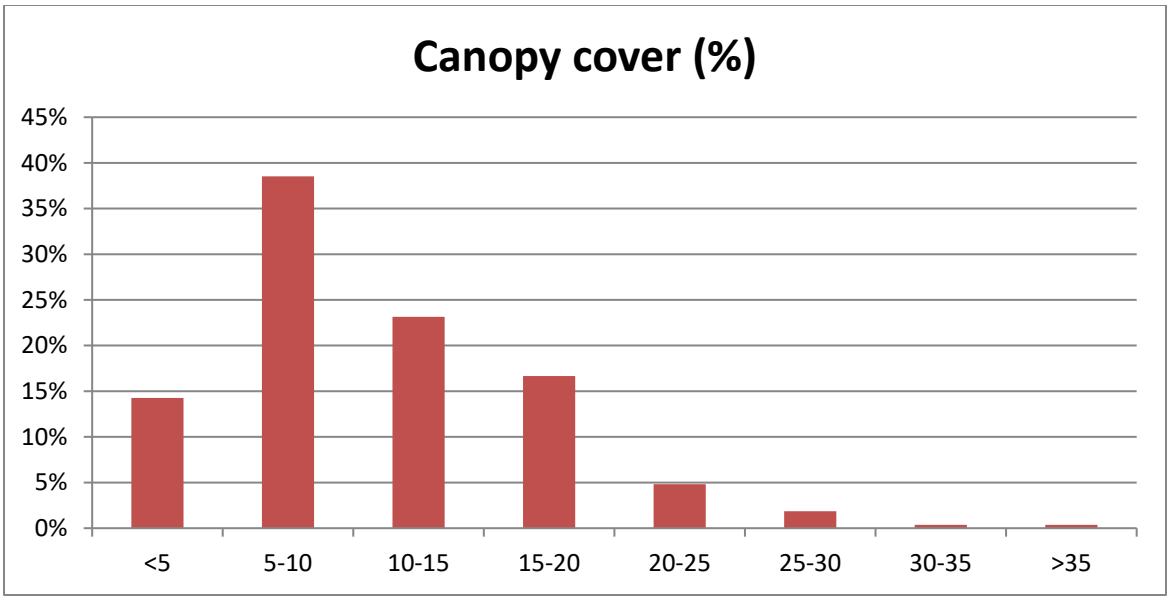



Graph 7 : repartition in percentage of trees' height in sacred groves

| height | <10 | >11-<20 | 21-30 | 31-40 | 41-50 | 51-60 | 61-70 | >70 |
|---|---|---|---|---|---|---|---|---|
| nbre | 12 | 54 | 86 | 102 | 128 | 93 | 53 | 12 |
| % | 2.22% | 10.00% | 15.93% | 18.89% | 23.70% | 17.22% | 9.81% | 2.22% |

Table 8 : repartition in percentage of trees' height in sacred groves

As we can see on these datas, the majority of trees' height in sacred groves are between 31 and 60 feets (76% to total population)




Graph 8 : repartition in percentage of trees' canopy cover in sacred groves

| canopy cover | <5 | 5-10 | 10-15 | 15-20 | 20-25 | 25-30 | 30-35 | >35 |
|---|---|---|---|---|---|---|---|---|
| Number | 77 | 208 | 125 | 90 | 26 | 10 | 2 | 2 |
| % | 14.26% | 38.52% | 23.15% | 16.67% | 4.81% | 1.85% | 0.37% | 0.37% |

Table 9 : repartition in percentage of trees' canopy cover in sacred groves

The majority of trees' canopy cover in sacred groves are between 5 and 15 meters (61.67%). This measure is very important. Indeed it is directly propotional to the yield / harvest, the more the canopy cover is important the more the harvest would be significant.

It has been made clear in these results that trees in sacred groves are taller and their canopy cover is bigger than trees in the others areas. So, fruits yield in sacred groves should be bigger than fruits yield in road side and human settlements.

Secondly, on the canopy cover graphe, we can see a huge STDEV for sacred groves (more than 7meters) whereas in the other areas STDEV is small. This is explain by the fact that sacred groves are differents and in sacred groves trees' characteristics are very heterogeneous, some of them are older than other. Next to boundaries or roads they're dammage by humans, thus they are smaller than the others. Trees in the center of sacred grove can grow up without constraints.

Moreover in sacred groves trees grow up without human's constraints whereas in others places they grow up with human's constraints.

## B. Discussion

*T. bellerica* is present in all sacred groves visited for this survey. Moreover trees are present with about 9.36 trees/ha. So these sacred groves can be concerned by AERF project.

Generally the *T. bellerica* present in sacred groves have a large canopy cover, and a height taller.

But there are some sacred groves with few *T. bellerica*, whereas other sacred groves have a lot of *T. bellerica*. The distribution of this tree is very heterogeneous.

Besides, trees on sacred groves grow up without human constraints contrary to in road sides or human settlements, so that they are higher and bigger than in these areas (graph 2, 3 and 4).

Local villagers use to slice *T. bellerica* as a fuel wood and in the same time increase fields. Next to their fields, branchs are cut to clear cultures. That's why boundaries trees have the smallest canopy cover. A tree with a little canopy cover will produce less fruits than a tree with a normal canopy cover.

About the accessibility, sacred groves accessibilities are very variables. Some of them like Katavali, Pangari, Dhamani and Kule are escarped and prickled, so harvests seem to be difficult. Dense vegetation and many spines should be an obstacle for good harvests. Others have good roads and areas are very accessible like Muradpur, Pur, Devede, Kirbet, Padgaon, Vighravali.

Little sacred groves are more threaten than large sacred groves. So we have to take care of accessible and little sacred groves, in particularly fauna and flora.

# IV. CONCLUSION

This study is a part of AERF project on sacred groves conservation. The project leans on the commercialization of *T. bellerica*'s fruits. That's why a preliminary study on morphology of *T. bellerica* had been required.

This paper has gone through a huge heterogeneous of sacred groves. However, all visiting sacred groves have more or less a potential for *T. bellerica* harvests. That's an encouraging conclusion for continuation of this project.

Some others sacred groves or different types of forests are present around the world. So the threat on forests can be stop by some projects like this one. In Himalaya, a project very close to this one was a success (L., McNeely, McCarty, & Smith, 2006).

We're very glad to take part of this survey, and we trust that the project will have a successful issue.

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