

Environmental sustainability of increasing silk demand in India

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ABSTRACT

Natural resources competition between food and cash crops is a current challenge in many developing countries that are experiencing both lack of food availability and a fast-growing economy, such as India. Silk industry has always been significant for the Indian economy since it provides high profits and employment. Almost 90% of the world commercial silk production is mulberry silk. Recently, to the aim of increasing silk production in the Country, the Central Silk Board of the Indian Ministry of Textile and the Indian Space Research Organization have identified potential suitable areas for mulberry cultivation through horizontal expansion in wastelands. Here, taking India as a case study, we analyse if the current cultivation of mulberry silk and the horizontal expansion of moriculture is environmentally sustainable. To this end, using the present land cover, we use a dynamic spatially distributed crop water balance model evaluating mulberry water requirement, the green and blue water provision and analysing both water scarcity at pixel scale and the impact of present and future moriculture on its increase.

Results show in the baseline scenario some States (e.g. West Bengal, Bihar, Tamil Nadu, Madhya Pradesh, Uttar Pradesh, Karnataka, Telangana) suitable for mulberry horizontal expansion already experiencing water scarcity conditions and high prevalence of malnutrition that will be exacerbated, both on yearly and monthly scale, by increasing moriculture. Other States (i.e. Orissa, Chhattisgarh, Mizoram, Assam, Manipur, Tripura, Meghalaya and Nagaland) show Mulberry expansion as the triggering factor of water scarcity condition. Particularly affected by water scarcity will be the North-Eastern Indian districts where potential mulberry areas are clustered.

The analysis of the population exposure to water scarcity due to mulberry horizontal expansion shows 11 million people potentially affected in India, where more than 65% living in the North-Eastern States. Compared to the total North-Eastern Region inhabitants, affected population accounts for more than the 15%.



SILK PRODUCTION

Moriculture

Mulberry production as food for silkworms

Industry sector

Silkworm growth, cleaning, drying and cooking cocoon, reeling silk

>99% of the total blue water footprint
(Hogeboom and Hoekstra, 2017)

<1% of the total blue water footprint
(Hogeboom and Hoekstra, 2017)

Silk production challenges SDGs:

2. ZERO HUNGER

Less kilocalories intake using land for non-edible crops instead of producing food crops

6. CLEAN WATER AND SANITATION

Mulberry production is water intensive and 80% of mulberry fields are irrigated
(Rajaram and Qadri, 2014)

Silk production supports SDGs:

15. LIFE ON LAND

Mulberries increase green cover and help preventing soil from erosion
(Linder, D., 2015; inserco.org)

1. NO POVERTY

Labour intensive
(Hogeboom and Hoekstra, 2017; inserco.org)

5. GENDER EQUALITY

Largely employs women
(Mittal et al., 2019; Rubia et al., 2019; Ganie et al., 2012; inserco.org)

8. DECENT WORK AND ECONOMIC GROWTH

Provides a good income and improves rural economy
(Ganie et al., 2012; inserco.org)

13. CLIMATE ACTION

Low carbon emitting
(inserco.org)



INDIA: WATER AND FOOD CRISIS vs SILK PRODUCTION

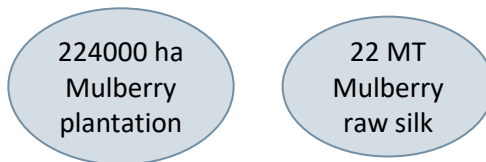
Increased pressure on natural resources
due to climate change, population
growth, change in diets



Trade-offs between food and cash crops

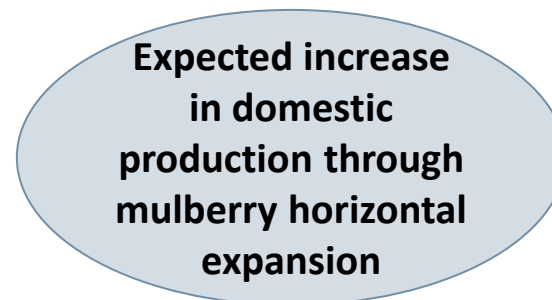
Imbalance between silk demand in India and its domestic production

CURRENT PRODUCTION



Ministry of Textile (2019)

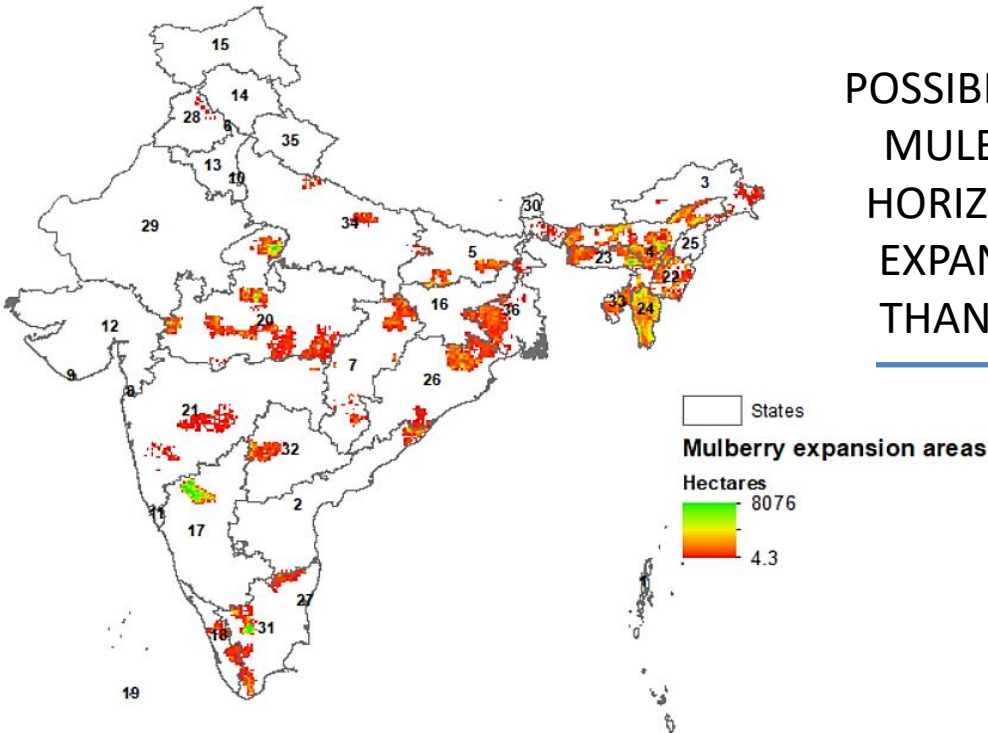
NEXT FUTURE?



(Handique et al., 2016)



STUDY QUESTION



POSSIBILITY OF
MULBERRY
HORIZONTAL
EXPANSION
THANKS TO



The concerns of Indian
Ministry of Textile
about the decrease in
silk production in
2014/15

Available and suitable
wasteland according
to the *Sericulture
Information Linkages
and Knowledge System
(SILKS)*

(Handique et al., 2016; Singh et al., 2016)

**IS IT POSSIBLE TO PRODUCE MULBERRY IN THE EXPANSION AREAS
CONSIDERING THE ONGOING WATER AND FOOD CRISIS IN A
SUSTAINABLE WAY?**



METHODS

INTERVAL OF TIME: 2010-2016 average

- Evaluation of mulberry water requirements using a spatially distributed crop water model described in (Rosa et al., 2018)
- Assessment of water scarcity (on a monthly and yearly basis) for the present situation and for the forecasted scenario with increase in mulberry harvested areas according to (Mekonnen and Hoekstra, 2016)

$$BWS = \frac{BWF_{loc}}{BWA} = \frac{Ind + Dom + Agr}{WA_{loc} + \sum_{n=1}^n (WA_{up,i} + WF_{up,i})}$$

- Affected population by increase in water scarcity due to mulberry horizontal expansion
- Food security analysis with food crop replacement in mulberry expansion areas



WATER REQUIREMENT COMPARISON



Estimated raw silk BWR

in Karnataka, Tamil Nadu and Andhra Pradesh respectively 71, 41 and 47 m³/kg

≈

Literature raw silk BWR

which is estimated as 54 m³/kg (Astudillo et al., 2014)

>

Literature cotton BWR

which is equal to 7 m³/kg (Astudillo et al., 2014)

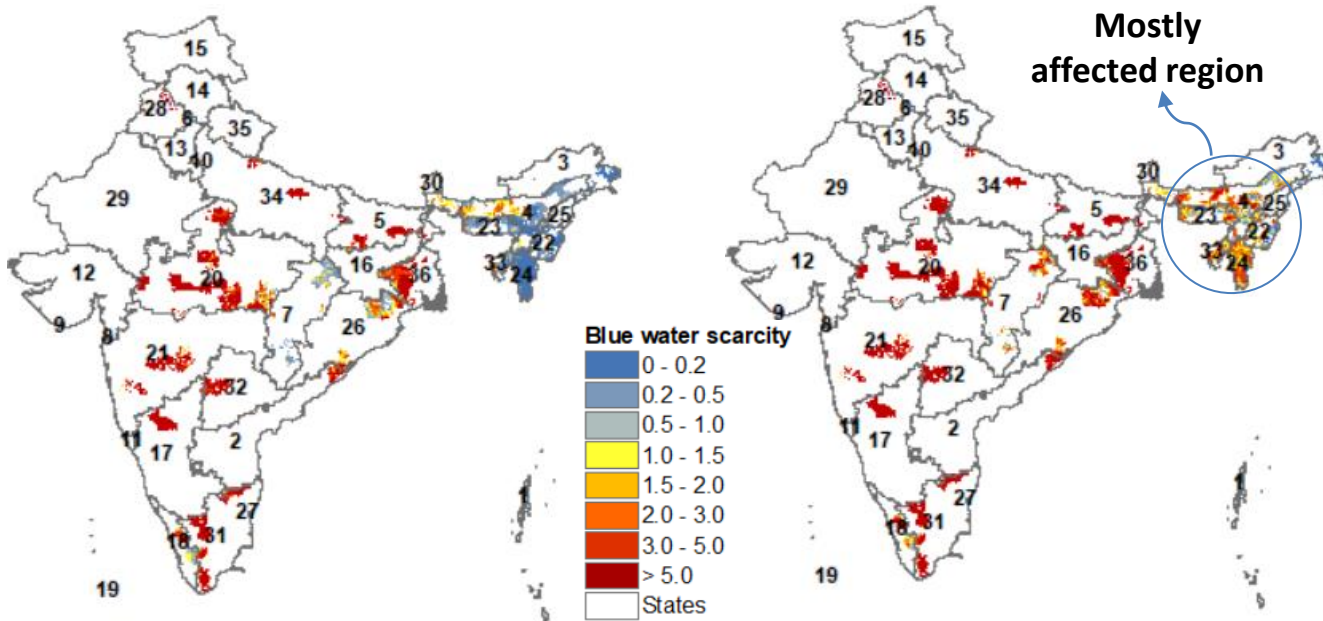
BWR = Blue Water Requirement



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COMPARISON BETWEEN BASELINE AND MULBERRY SCENARIOS

Water scarcity on yearly basis



Baseline Scenario for 2010-2016 average

Mulberry Scenario for 2010-2016 average

Population analysis

11 million more people exposed to mulberry water scarcity

65% living in the North-Eastern Region (NER)

Food security analysis

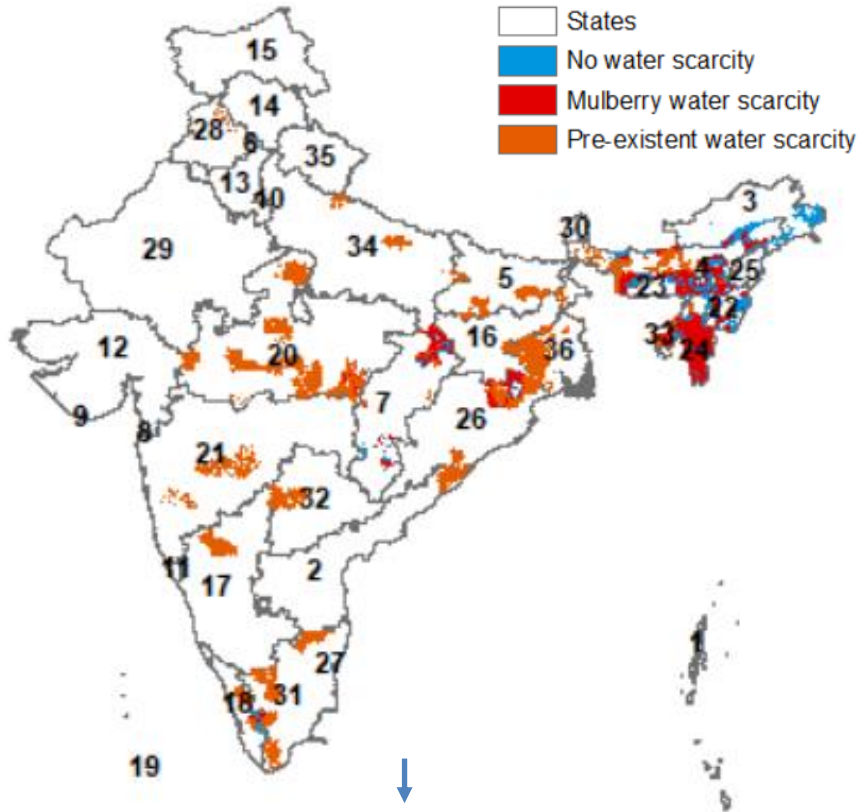


Loss of 32 kcal/cap/day considering countrywide replacement of mulberry expansion areas with currently harvested food crops in accordance with their prevalence in each cell



TYPE OF WATER SCARCITY

YEARLY BASIS



**FEW MULBERRY AREAS
WITHOUT WATER SCARCITY**

North-Eastern Region (NER)

- Potential economic hub thanks to vast water resources (Roy and Shil, 2015)
- Lowest values of water scarcity in the baseline scenario than in any other region



**WATER SCARCITY DUE TO MULBERRY
HORIZONTAL EXPANSION**

Other Indian States

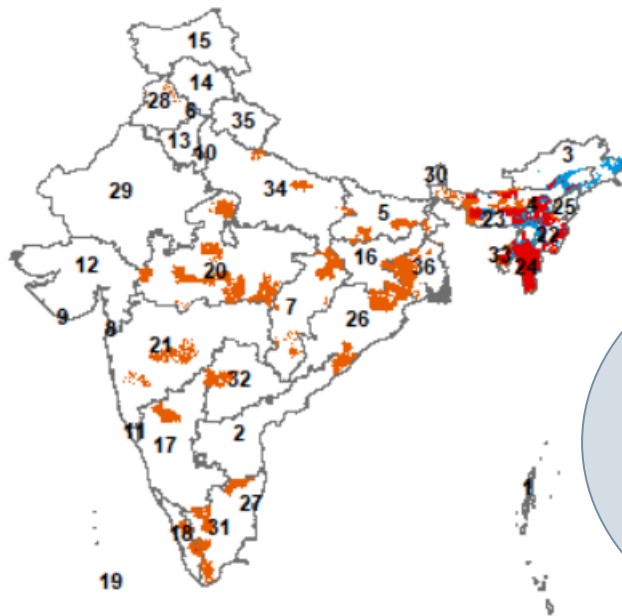
- Significant increase in mulberry harvested areas in Tamil Nadu and Madhya Pradesh in latest years (Bhat et al., 2014)
- Already under water scarcity conditions in the baseline scenario especially in arid season



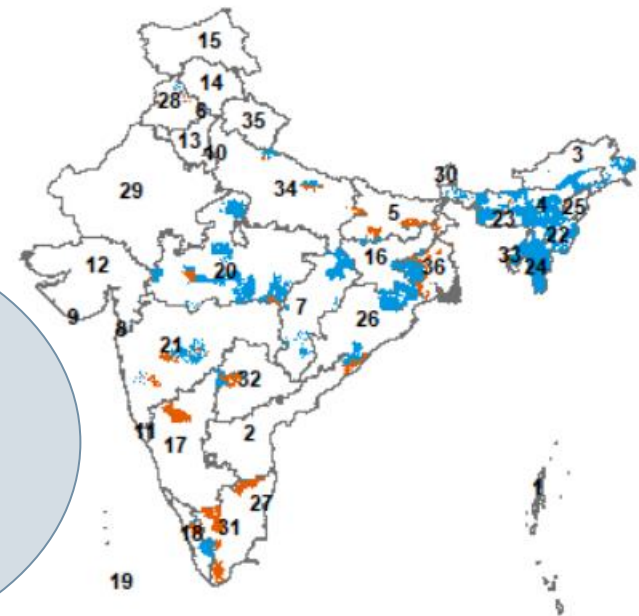
**MULBERRY EXPANSION EXACERBATES
WATER SCARCITY CONDITIONS**

TYPE OF WATER SCARCITY

APRIL



AUGUST



Tripura, Mizoram, Assam and Manipur in NER are the most affected states by mulberry water scarcity

PRE-MONSOON MONTHS ARE THE MOST AFFECTED BY MULBERRY EXPANSION

MONSOON MONTHS ARE THE LEAST AFFECTED BY MULBERRY EXPANSION



CONCLUSIONS

PROs

SILK PRODUCTION

CONs

EMPLOYMENT

Employs more than 7 Million people, mostly in rural areas

(Ganie et al., 2012)

WOMEN EMPOWERMENT

Around 60% of the workers are women

(Mittal et al., 2019; Rubia et al., 2019; Ganie et al., 2012)

WATER AND FOOD INSECURITY

Widespread water scarcity in not yet water scarce areas of India (eg NER)

Very few mulberry expansion areas do not undergo water scarcity conditions

Competition for land use between food and cash crops

The most **environmentally sustainable solution** for increasing silk production in India considers mulberry horizontal expansion in harvested areas that prevent from having water scarcity conditions



THANK YOU FOR YOUR ATTENTION

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