# Arth Ganga Project: District Vaishali

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*Submitted to*

National Mission for Clean Ganga (NMCG)

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# EXECUTIVE SUMMARY

The birthplace of Mahavir or Vardhaman, Vaishali, is an agrarian district with historical importance is located in the state of Bihar. It is one of the economically backward districts of the country is bounded by rivers Ganga and Gandak.

The total geographical area of the district is 2036 $Km^2$, out of this area, the total cultivable land is 150200 ha, the permanent pastures are 400 ha, the Cultivable wasteland is 5400 ha. The barren and uncultivable land constitutes 1900 ha. Majorly soil types are Sandy soil, coarse sandy loam soil, fine sandy loam soil, Clayey soil, and Saline/ Calcareous soil. With the net sown area of 150200 ha and gross cropped area of 202800 ha, the Cropping intensity of the district is 135%. The net irrigated area is 39800 ha whereas the rainfed area is 110300 ha. The major crop types are wheat, rice, maize, pigeon pea, etc. Among the horticulture fruits are mango, litchi, banana, etc. whereas the horticulture vegetables are potato, cauliflower, tomato, okra, etc. The livestock consists of cattle and goats, buffalos, goats, sheep; along with poultry and fisheries.

The total forest cover of the district is only 111.81 $km^2$. The district is a forest cover deficit. Out of total forest cover, the maximum area is covered by Moderately dense forest (82.49$km^2$) followed by Open Forest (29.33 $km^2$). Forest monitoring tool has been introduced in the district. The district has 343 species of birds and 9 species as accidental species. The district comprises small and medium-sized, 402 wetlands; most are waterlogged and lake/ponds/tanks. Salim Ali-Jubba Sahni Bird Sanctuary is a hub of biodiversity and is a tourist attraction. The number of natural wetlands is more than man-made. The district is of great importance to Jainism and Buddhism cultures. It attracts many domestic and foreign tourists with certain fluctuations in several visitors. Lord Buddha delivered his last sermon and thus the Ashoka pillar and Buddha stupa built here is a major tourist attraction. Raja Vishal Ka Garh, Abhishek Pushkarni, Vishwashanti stupa, fair at Ramchaura, Hajrat Jandaha, Karbala, and tombs of Hajipur, Serukhi, etc. are placed with high tourist attractions with different cultural backgrounds.

The main source of lightning is kerosene (87.83%) closely followed by electricity (11.07%) while only 0.42% is the usage of Solar energy. Saur Energy International has been set up. The main fuel source is firewood (50%) followed by crop residue (29%) and LPG/PNG usage is only 7%. The biomass production is high due to high agricultural practices. Biogas potential from animal waste is calculated approximately as 1 crore $m^3$/year and 12 crores $m^3$/year from agricultural waste. No hydropower plant exists, nor future projects have been proposed in the district.

To enhance its economy along with development and reduce pollution the district needs to promote the use of renewable energy along with monitoring and creating awareness. Afforestation, Miyawaki Plantation, eco-tourism, maintenance and promoting of tourist sites along with facilitating accommodations, etc. should be adapted in the district. Resource conservation technologies, Micro-irrigation, organic farming, awareness, training, and participation by the

farmers, adopting poly house and greenhouses, gypsum application, Vermicomposting, and green manuring, advising on the use of pesticides and flood modulation, stressing on storage units and exports, etc. are a few practices that need to be incorporated in the agriculture sector. Also, certain practices such as the cultivation of medicinal plants and salt-tolerant crops, mushroom and flower cultivation, Poly house and greenhouse, inter-cropping, etc along with encouraging beekeeping, fisheries, dairy, and animal husbandry, etc. should be adapted and encouraged in the district.

# 1 DISTRICT OVERVIEW

## 1.1 INTRODUCTION

Vaishali district is a district in the Indian state of Bihar. It is a part of Tirhut division. Vaishali district is located on global map between 25°41' and 25°68' North latitude and 85°13' and 85°22' East longitude. The district occupies an area of 2,036 square kilometers. The rank of the district in comparaison to other districts of Bihar in terms of area is 25$^{th}$. The district is surrounded by Muzaffarpur district in the north, Ganga River and Patna District in the south, Samastipur district in the east, Gandak River and Saran district in the west. The district has a 5.49% forest area of the total geographical area. Administration wise, the district has 3 sub-divisions namely Hajipur, Mahnar, and Mahua which are again divided into 16 developmental bloks. There are 2 Lok Sabha and 8 Assembly seats. The district comprises of 3 towns and 1569 villages.

The district of Vaishali with a population of 34,95,021 according to 2011 Census. Vaishali is a large sized district and ranks 10th in the state in order of population. The district has a population density of 1,717 inhabitants per square kilometer. Vaishali has a sex ratio of 892 females for every 1000 males and a literacy rate of 66.60%. The work participation rate (WPR) in the district is 20.49 percent for main workers and 9.85 percent for marginal workers. Proportion of non-workers in the district is 69.66. The economic activity in the rural areas of the district is supported by the fact that the cultivators (25.12 %) and agricultural labourers (49.24 %) together constitute 74.36 percent of the total workers of the district. The agriculture sector has absorbed around 3/4th of the total workers.

Agriculture is the main occupation of the people of the district and also the main source of livelihood of the people. Rice, maize and wheat are the main crops of the district. Sugar-cane tobacco, potatoes are the cash crops grown in the district. The district headquarters Hajipur is famous for the very good varieties of banana produced here. It is exported to other places also. It is scantily industrialized, only a few mills and factories are available in it. Sugar mills are commonly found in the district.


*Figure 1 Map of the district*

## 1.2 DEMOGRAPHIC PROFILE OF VAISHALI

Geographic area: 2,036 $Km^2$
Altitude: 58 m
Rainfall: 570.1 mm (2018-19)
Forest area: 111.82 $Km^2$
Rivers: Ganga

Administrative Divisions:

| | |
|---|---|
| District Headquarter | Hajipur town |
| No. of subdivision | 3 |
| No. of Blocks | 16 |
| No. of Villages | 1572 |

Demographic and Socio-economic Parameters:

| | |
|---|---|
| Population | 34,95,021 |
| Population Density | 1717 / $Km^2$ |
| Sex Ratio | 895 |
| Literacy | 66.6% |
| Occupation/Livelihood | Agriculture |

## 1.3 AGRO CLIMATIC PROFILE OF THE DISTRICT

## 1.4 ECONOMIC PROFILE OF VAISHALI

The economy of the district is solely dependent on agriculture. The adoption of the new agricultural technologies amongst the farmers of the district helps to increase the production of various agricultural items. Some of its chief agricultural products are banana, paddy, wheat, maize, lentils, etc. Every year a huge chunk of revenue comes from these agricultural products. It is scantily industrialised, only a few mills and factories are available in it. Sugar mills are very commonly found in it. In 2006 the Ministry of Panchayati Raj declared Vaishali as one of the country's 250 most backward districts and currently receiving funds from the Backward Regions Grant Fund Programme (BRGF). In the year 2011-12 the gross domestic product in the district was Rs. 6,52,374 lakhs at current price and Rs. 3,96,206 lakhs at constant prices in the year 2004-05. In the year 2011-12 the net domestic product in the district was Rs. 5,90,745 lakhs at current price and Rs. 3,53,746 lakhs at constant prices in the year 2004-05 (IndiaStat).

# 2 QUANTITATIVE DATA ANALYSIS

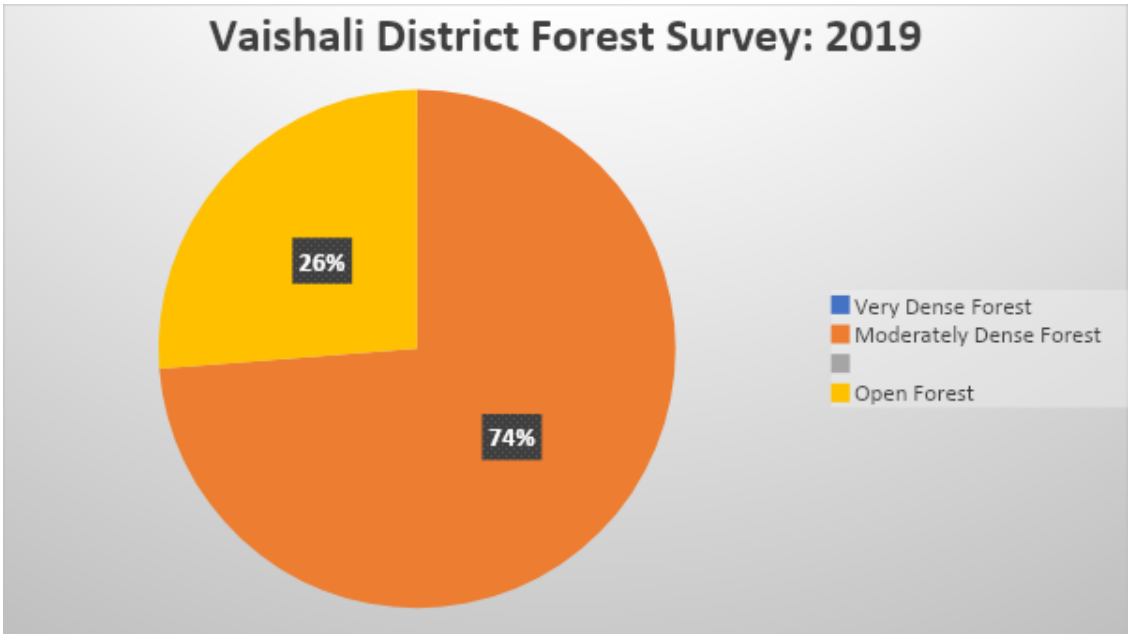
## 2.1 Agriculture and Allied Activities

## 2.2 Trends in Livestock

## 2.3 Forestry

District of Vaishali has 2036 $Km^2$ total geographic area. Forest cover area as per 2019 forest survey assessment is 111.81 $Km^2$. This is 5.5% to the total area which makes district forest deficient area. The state has total 7305.99 $Km^2$ forest area which is 7.75% of total geographic area of the state.

Vaishali district does not have forest under the category of Very Dense Forest (VDF), 82.49 $Km^2$ of area comes under the category of Moderately Dense Forest (MDF) and 29.33 $Km^2$ is open forest (OF) as per 2019 assessment.




| Forest Survey of India 2019 Bihar State vs Vaishali Comparative Assessment | | | | | | |
|---|---|---|---|---|---|---|
| Area | Geographical Area | Very Dense Forest | Moderately Dense Forest | Open Forest | Total | %of Geographical Area |
| Vaishali | 2036 | 0 | 82.49 | 29.33 | 111.82 | 5.5 |
| Bihar | 94163 | 333.13 | 3280.32 | 3692.54 | 7305.99 | 7.76 |

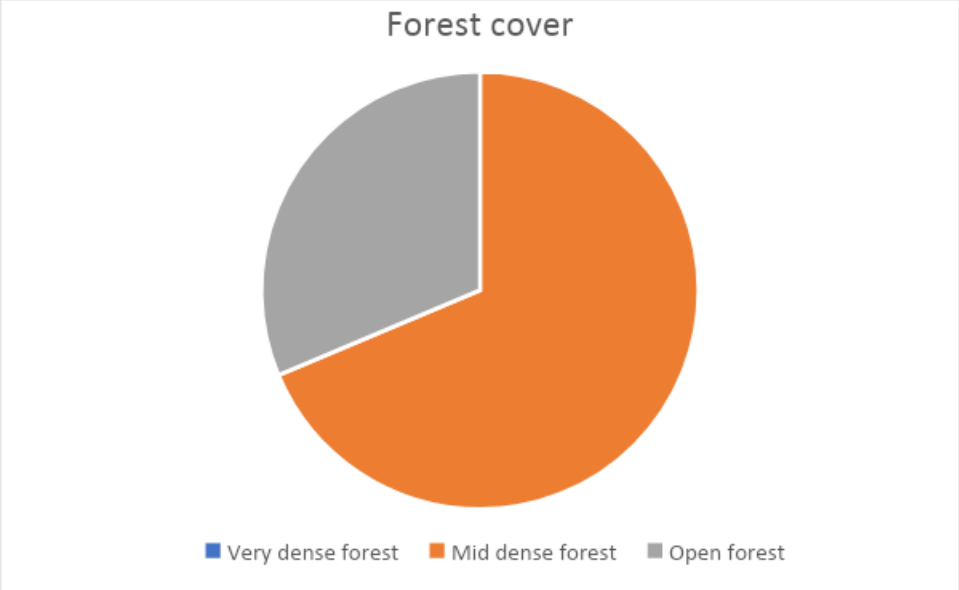
**2.3.1. Biodiversity:** The district's biodiversity data includes livestock population, bird species, and forest cover. The district has a forest area of 111.82 square km, in which 60% area is mid-dense forest, and 40% area is open forest. According to the world bird database (avibase), there are 343 species of birds present in the district, and nine species are in the accidental category.

*Table 1 Bird species recorded in the district.*

| | |
|---|---|
| **Number of species** | 343 |
| **Number of rare/accidental species** | 9 |
| *https://avibase.bsceoc.org/checklist.jsp?lang=EN&p2=1&list=clements&synlang=&region=INwhukut&version=text&lifelist=&highlight=0* | |

**Forest cover (in sq. km.)**

| Geographical area | Very dense forest | Mid dense forest | Open forest | Total | % of Geographical area ` | Change with respect to 2017 assessment | Scrub |
|---|---|---|---|---|---|---|---|
| 2036 | 0 | 82.49 | 29.33 | 111.82 | 5.49 | 2.82 | 0 |




## 2.4 Tourism

## 2.5 Wetlands

The district has vast wetlands consisting of large lakes and ponds like Tal Baraila, Salah Chaur. Table 1 shows the number of wetlands and their area representation in the district. Around 127 wetlands sized greater than 2.25 Ha and 275 less than 2.25 Ha areas. The region consists of a mix of small and large wetlands, generally less than 200 Ha in the area, but 3 are greater than 200 Ha.

**Table 1: Wetland Data of Vaishali District**

| | Total Number of | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Wetlands: | | | Area (ha) | | | | | | | | | Aquatic Vegetation |
| **Natural Wetlands** | **NRCD** | **NWIA** | **Diff.** | **<2.25** | **<5** | **<10** | **<20** | **<50** | **<200** | **<500** | **<1000** | **>1000** | |
| Lake/ponds | 27 | 31 | 4 | 0 | 0 | 6 | 4 | 4 | 10 | 1 | 1 | 1 | 16 |
| Ox-bow lakes/cut off meanders | 6 | 6 | 0 | 0 | 1 | 1 | 0 | 3 | 1 | 0 | 0 | 0 | 3 |
| High altitude Wetlands | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Riverine Wetlands | 5 | 5 | 0 | 0 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Waterlogged | 61 | 61 | 0 | 0 | 4 | 10 | 10 | 17 | 20 | 0 | 0 | 0 | 37 |
| River/Stream | 0 | 16 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Man-made Wetlands** | **NRCD** | **NWIA** | **Diff.** | **<2.25** | **<5** | **<10** | **<20** | **<50** | **<200** | **<500** | **<1000** | **>1000** | **AV** |
| Reservoirs/Barrages | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Tanks/ponds | 1 | 7 | 6 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Waterlogged | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Salt pans | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total (402)** | 101 | 127 | 26 | 275 | 7 | 20 | 16 | 24 | 31 | 1 | 1 | 1 | 57 |

Source: (National River Conservation Directorate, 2008), (Space Application Centre-ISRO, 2007)

- The district comprises 402 wetlands; most are waterlogged and lake/ponds/tanks.
- The wetland size is small and medium-sized in general.
- The number of natural wetlands is more than man-made.
- Half of the wetlands (>2.25 ha) have aquatic vegetation.

Some of the known wetlands that exist in the district with their area (in Ha) are as follows:

| Natural wetlands (lake/ponds) | | Natural wetlands (waterlogged) | | Man-made wetlands (tanks/ponds) | |
|---|---|---|---|---|---|
| 24.33 | Belwari Chaur | 4.02 | Lakaina Chor | 3.05 | Ghordaha Pokhra |
| 53.96 | Ramdhobhi Chor | 5.07 | Vaishali Garh | | |
| 59.38 | Hariya Chaur | 8.84 | Kahuwa Chor | | |
| 61.69 | Chatur Manda | 111.22 | Berai Chor | | |
| 85.59 | Billi Tal | 130.23 | Puraniya Chor | | |
| 121.86 | Lochna Chor | 142.26 | Boaria Chor | | |
| 226.2 | Pahetia Chor | 145.47 | Powra Chor | | |
| 614.13 | Salah Chaur | 4.02 | Lakaina Chor | | |
| 1158.87 | Tal Baraila | 5.07 | Vaishali Garh | | |

## 2.6 Energy

### 2.6.1. Solar Energy

BREDA i.e. Bihar Renewable Energy Development Agency, has been established to promote development of schemes on non- conventional energy sources. BREDA aims to work as a Catalyst for Change by utilizing the Best Renewable Energy Technology to cater to the ever growing Growth Potential of Bihar.

According to the 2011 census (as depicted in figure), 87.83% households use kerosene as the main source of lightning. 11.07% use electricity and only 0.42% use solar as the main source of lightning. These figures indicate that the number of people using solar energy is quite low.

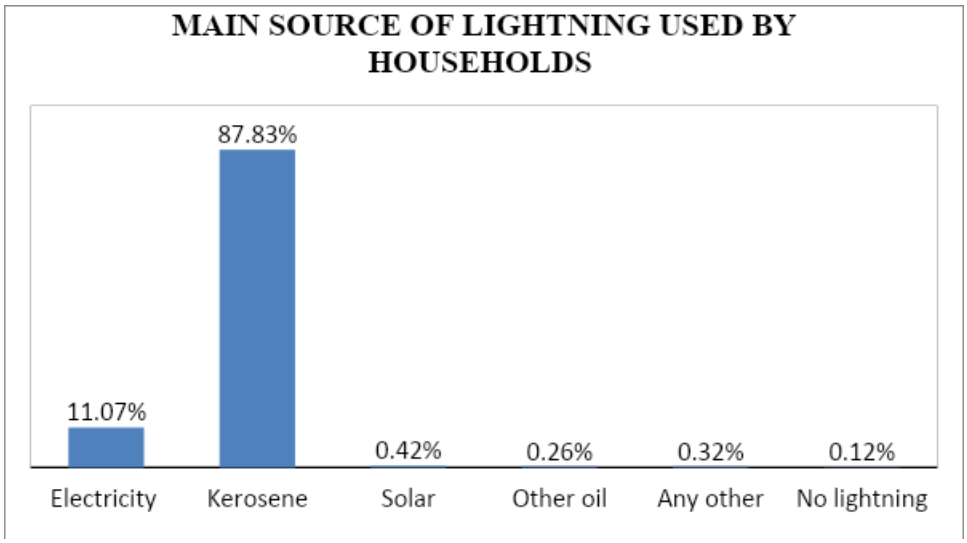



**Fig. 1**

The district has a good potential of solar energy. According to Pugazenthi et. al. (2016), the total solar power potential available in the district Vaishali is 0.0372.
There is not sufficient data available giving the account of the solar power units in the district.

### 2.6.2.Biomass Energy

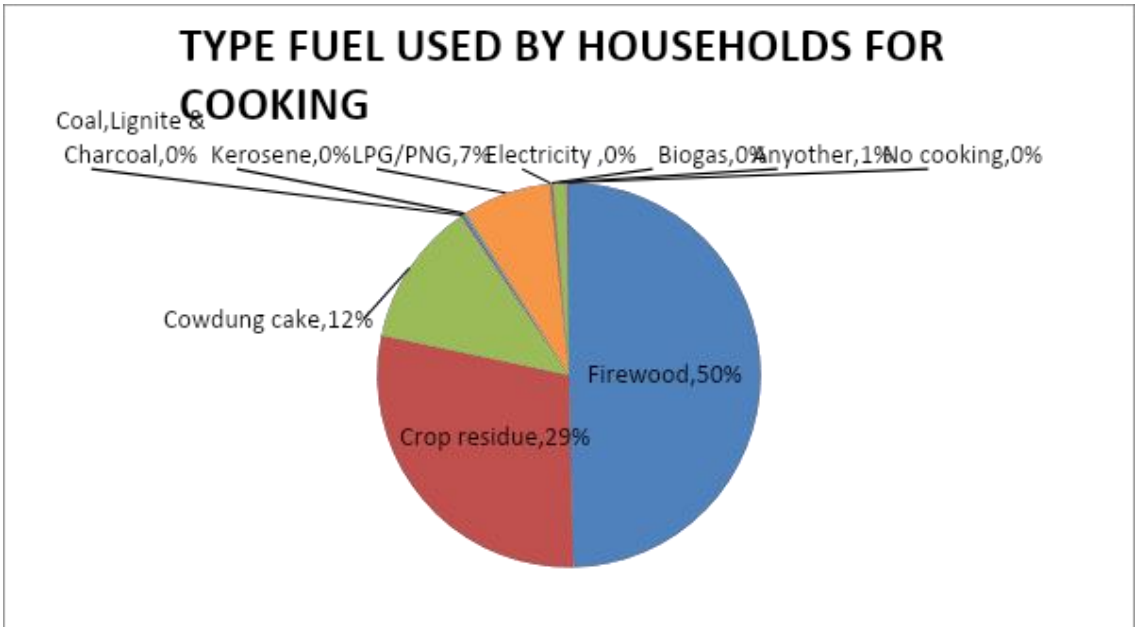
BREDA i.e. Bihar Renewable Energy Development Agency, has been established to promote development of schemes on non- conventional energy sources. BREDA aims to work as a Catalyst for Change by utilizing the Best Renewable Energy Technology to cater to the ever growing Growth Potential of Bihar.
The district Vaishali depends on agriculture for its economy and livelihood. The gross cropped area of the district Vaishali is 202800 ha and the net sown area is 150200 ha with the cropping intensity of 135%. 52700 ha of the area is sown more than once a year. The major field crops of the district are rice, maize, wheat, blackgram, etc. and the major horticultural crops are mango, banana, litchi, lemon, etc. Table 1 gives an account of productivity of the major crops in the district:

| CROP | PROCUTIVITY (kg/ha) |
|---|---|
| Rice | 16 |
| Maize | 48 |
| Wheat | 26 |
| Chickpea | 10 |
| Rai & Mustard | 6.6 |
| Lemon | 7798 |
| Mango | 98 |

| | |
|---|---|
| Banana | 412 |

**Table: 1**

The pie chart given in Fig. 1 depicts the 2011 census on the type of fuel used by households for cooking. It is evident that 50% households use firewood, followed by 29% households using crop residue, 12% cow dung and only 8% LPG/PNG.
The district has a good potential of biomass potential. According to Pugazenthi et. al. (2016), the total biomass power potential available in the district Vaishali is 0.3757.




### 2.6.3.Biogas Energy

Three biogas plants of 2$m^3$ capacity have been installed in the year 2009-10. Biogas potential has been evaluated by average livestock and agricultural waste production. Biogas potential from animal waste is calculated approximately as one crore $m^3$/year and twelve crores $m^3$/year from agricultural waste. This amount of biogas generation can efficiently complete the energy demand of the district.

### 2.6.4.Hydropower Energy

The district is situated between 25° and 30° North latitude and 84° and 85° East longitude. The district is bounded on the south by the Ganga and on the west by the Gandak. Muzaffarpur lies in the north, while Samastipur is in the east. The district is located on the semitropical Gangetic plane.

The district encompasses an area of 2036 square kilometers. No hydropower plant exists, nor has the site been identified for future projects in the district for small hydropower plants.

# 3 QUALITATIVE DATA ANALYSIS

## 3.1 AGRICULTURE, ALLIED ACTIVITIES,

## 3.2 FORESTRY

Forest Survey 2019 assessment reported variety of native trees in rural and urban areas across the state. These common species are Mangifera indica, Bombax ceiba, Psidium guyava, Dalbergia sissoo (FSI, 2019). Currently, State government forest department runs 'Krishi Vaniki Yojana', a scheme which primarily focuses on to motivate farmers to plant trees and other crops on a large scale along with traditional crops on their land. This scheme is aimed to improve the income of farmers in the event of crop loss and to contribute towards agricultural produce by growing popular trees such as Heesham, Guava, Gambhar, Amla, Mahogany, Teak, Peepal, Jamun, Kachnar, Gulmohar, Mango, Eucalyptus, Neem, Kadam, Bahera, Palas, etc. Farmers are provided seedlings of the trees in government nursery at the rate of Rs 10 / seedling. If farmers maintain 50 percent of the plants purchased from the forest department in their lands for 3 years, then for this, the farmers will be given an incentive of Rs 60 per plant. Moreover, the Rs 10 they spent for purchasing the seedling is also given back to the farmers (Krishi Yojana).

Recently, The United States Agency for International Development and Bihar's Department of Environment, Forest and Climate Change jointly launched forest monitoring tool. which will use satellite images and geo-analytics to improve forest monitoring, planning, and management in the state. This will help forests to pull more carbon out of the air, enhance water yields, and improve livelihoods for indigenous and tribal communities (Outlook, 2021).

Salim Ali-Jubba Sahni Bird Sanctuary is situated in the district.

**3.2.1. Biodiversity :** The region is of enormous ecological and environmental value due to its hydrological, wetland, and aquatic ecosystem functions. With protection in mind, the Government of Bihar designated the wetland as a sanctuary in 1997. However, in 2016, it was recognized in the Gazette of India as the Baraila Lake Salim Ali Jubba Sahni Bird Sanctuary (Gazette of India, 2016). During the summer (May-June), the entire marsh becomes dryland, with grasses replacing the wetland plants. Following the arrival of the monsoon towards the end of June, the sanctuary gets water from the catchment region and transforms into a wetland. Gandak canal, Baya River, and Noon River are further sources of water in the sanctuary. The Gangetic plains' wetlands are

critical to the survival of migrating water birds. The lake, which is located in the village of Braila in the Patepur block, is home to a variety of biological animals such as Pragmitis, Tifa, Hydrila, and Utroculeria. The lake provides a natural habitat for 59 species of migratory birds and around 106 species of local avians, including Teals Cormarants, Eagle, White Breasted King Fisher, Pied, Egreis poonbill, Pelicans, Coots, Grebes, Green parrot, Gull, and Lalsar, among others. The Baraila Lake provides habitat not just for migratory and resident water birds, but also for a variety of other animals like as fish, amphibians, and reptiles.

The principal permanent species of this refuge are the Indian Shag, Red collard dove, Asian Koel, Small Bee catcher, Brahmany starlet, and tree pie, while the migratory birds include the Black Ibris, Brahmany Shell Duck, Bar-headed Goose, Oriental Magpie Robin, and Lesser Whistling duck.

Oak Bhatel, located on marshy surfaces, was highly prevalent here and was known locally as "Ejara." It was the birds' favorite tree. Red-Cotton, like other indigenous plants, was fairly common here. The lake, which is located in the village of Braila in the Patepur block, is home to a variety of biological animals, including Pragmitis, Tifa, Hydrila, Utroculeria, and other microorganisms. The water runs via many local rivers, notably Noon, before joining the famed Budhi Gandak.

## 3.3 ENERGY

### 5.5.1. Solar

The district Vaishali has a good solar power potential. The concerned authorities have been trying constantly to develop and improve the economy and livelihood of the people in the district. According to an article in Saur Enegy International a Bihar-based startup Hemlet and Solar Project Collaborators are to set up 500 MW capacity solar project in Patepur block of Vaishali district in Bihar with an investment of about Rs 3,600 crore. There has not been much work done in Vaishali. The district needs to plan a strong base since it a good potential.

### 5.5.2. Biomass

The district Vaishali has a good potential of biomass energy, it produces large amount of biomass waste in form of agricultural waste. Not much has been found from the available resources about the biomass sector in the district Vaishali. Moreover the district suffers the problem of stubble burning. An article in the times of India, about the stubble burning problem in the district with the heading 'Stubble burning adds to air pollution woes in Bihar'. According to the article - Deterioration in air quality in several parts of the state has become a common phenomenon during the winters. Several factors, including stubble burning, are responsible for rise in pollutants in the air.

The burning of crop residue, which is common in states like Punjab and Haryana, has also started picking up in Bihar with the advent in mechanised harvesting of crops. Around 900 farmers in Bihar have been penalised for stubble burning since September. Environmentalists have expressed concern over burning of crop residue and opined that the mechanised farming appears to be the key reason behind the problem. “It costs just one rupee to get a match box. However, hiring workers to clear crop residues would cost at least Rs 10,000,” a Vaishali farmer said.

### 5.5.3. Biogas

Rice-wheat is the predominant agricultural pattern in the Vaishali district, followed by fruits and vegetables. Poor rice and wheat production are mostly due to insufficient access to available water resources (economic scarcity). Crops, cattle, and occasional remittances from migrant laborers provide the majority of the income. The waste/manure from this agriculture and livestock can be utilized to provide energy for the district by the anaerobic digestion process.

### 5.5.4. Hydropower

The district is surrounded by rivers Ganga and Gandak and comes under the plain region. Rural areas in the district are affected by power cuts. Therefore hydropower potential can be harnessed from these rivers to provide electricity to rural areas.

## 3.4 TOURISM

## 3.5 WETLAND

The wetlands are the source of many ecosystems and habitats for various species. The wetlands create a unique ecosystem that supports many species simultaneously like aquatic, terrestrial, and human beings. Local stakeholders directly or indirectly depend on the wetland for their income and small-scale business. These businesses can be a great opportunity can be turned into a large-scale production hub using the right approach. The district is known for the sacred land of Jains and Buddhists and the district home to Barela Salim Ali Zubba Saheni Wildlife Sanctuary. The data collected and analyzed shows the region's production and possible product that can be derived from the raw product. The list of sources and the possible products are mentioned below:

- Maize, rice, and wheat production are recommended as commercial crops in the region, leading to flour.
- Oil production in the region like mustard, linseed, sesame can turn into a valuable market for oil production in the region.
- The district is known for sikki work (the humble blade of grass is hand-woven into delightful baskets and mats) and lac bangles
- Fruits like banana, mango have high productivity in the district

# 4 ACTION PLAN DEVELOPMENT

## 4.1 AGRICULTURE

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## 4.2 FORESTRY

Vaishali district is a forest deficient area. The major occupation in the district is agriculture and small-scale businesses. That is why the Government of Bihar had drafted an Agroforestry policy in 2018. The district lies under the agriculture category III. This categorisation had been developed on the basis of climatic condition, the geography of the region, soil condition and water availability. Major crops in the district are Rice, Wheat, Lentils, and Gram pulse. The study has suggested a variety of trees in this zone. Eucalyptus, Arjun, Jamun, Kadam, Semal etc are the suggested tree species in the flood-prone zone; whereas Shisham, Gamhar, Melia, Teak etc for the non-flood zone. Litchi, Mango, Jamun, Kathal, Guava can be the most profitable money yielding tress as part of agro-horticulture. Medicinal plants like Kalmegh, Aswagandha, Sarpgandh, Satawar, Lemongrass, Safedmusli etc are viable options in agroforestry (Govt of Bihar, 2018). Below are the important species which can be included under agroforestry:

| Fruits | Vegetables | Spices | Flowers | Aromatic Plants |
|---|---|---|---|---|
| Mango, Guava, Litchi, Banana, Pineapple | Solanaceous, Cucurbits, Onion, Okra, Beans | Turmeric, Ginger, Garlic, Coriander | Marigold, Rose, Tuberose, Gladiolus, Jasmin | Japanese Mint, Lemongrass, Pamaroja, Citronella |

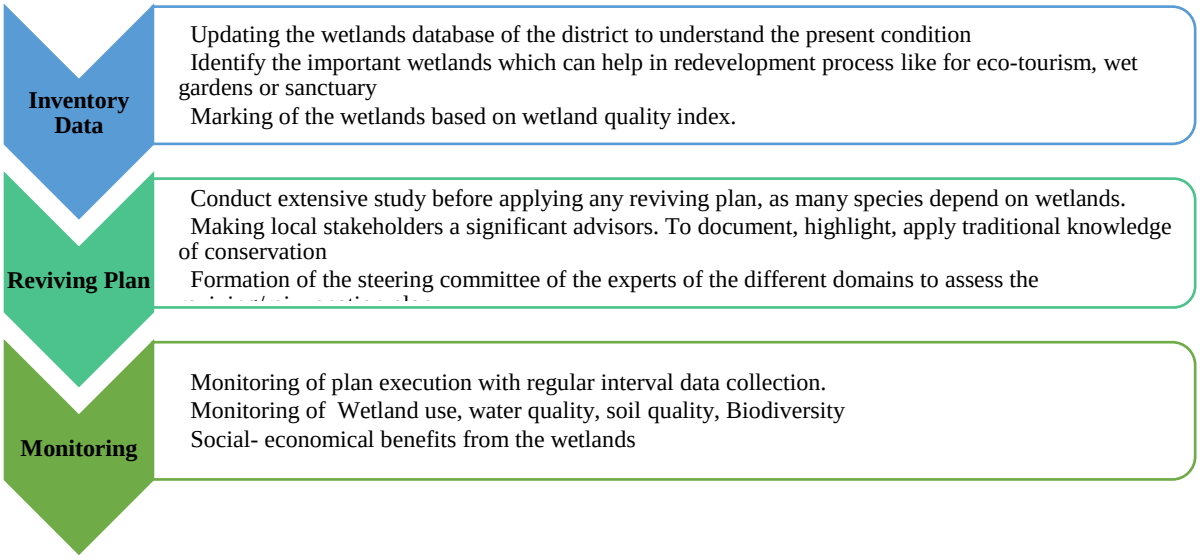
Afforestation on the riverbanks and open public spaces is another option that suits the vaishali district. Miyawaki afforestation method has been adopted by many urban authorities in the world. This technique helps to build dense, native forests. This method ensures that plant growth is 10 times faster and the resulting plantation is 30 times denser than usual. It involves planting native species in the available area and becomes maintenance-free after the first three years. The most important aspect of this method is it requires as minimum as 20 square feet of area. This can enable the native citizens of Vaishali to grow profitable fruit plants in the community. The combination of a small forest and home garden is known as homestead forest. With the combination of the Miyawaki method of afforestation and trading platform for these products, this combination can be beneficial for the local economy (Miyawaki Afforestation, 2019). Some of the major Indian cities like Mumbai, Chennai have also adopted this technique for afforestation (Indian Express, 2021). Afforestt is the firm that works in the development of Miyawaki Forest.

**4.2.1. Biodiversity :** The terms' national park' and 'wildlife sanctuary' are now widely used, and each country has classified a distinct forest region as a 'national park.' There are up to 21 national parks in India alone. This technique is a wonderful way to conserve forests. Government should work on afforestation or reforestation to increase forest area as only 5.5% of the area has forest and conserve some of that area for wildlife to protect species.

## 4.3 TOURISM

## 4.4 WETLANDS

The district is comprised of some of the healthy and wealthy wetland ecosystems. They directly or indirectly support millions of people and provide goods and services to them. They support all life forms through extensive food webs. They are habitat to aquatic flora and fauna and numerous species of birds, including migratory species. They mitigate floods and recharge the groundwater. They need to be taken care of, and action on different fronts must be taken. The action plan below gives a glimpse of the action and development required to protect, conserve, rejuvenate the wetlands existing and extinct.




## 4.5 ENERGY

### 4.5.1 Solar

The solar energy has a good potential in the district Vaishali. If proper steps taken then the district can develop with the help of solar power and also generate employment. The primary thing required for the development of solar energy in the district is to make people aware about the solar energy schemes. This will encourage people to incline towards the solar energy and also generate

employment opportunities. Other than this Kusum Yojana should be promoted among farmers, which will help them to perform the agriculture activities using the advanced tools. This would ultimately bring efficiency in farming. The small scale industries should also be given the benefit of net metering and subsidy so that they don't have to wait for longer periods to get returns. The remote areas where the infrastructure supporting grid connected solar rooftop panels is not developed should be provided with the financial assistance for the off grid connections. This will not only promote a clean and green energy moreover the livelihood as well as the economy of the district would be improved.

**PROJECTION AND MONITORING MATRIX**

Firstly, the government should make different sections of the district aware about the solar energy and which scheme should be specifically good for them.
Secondly, the farmers should be educated about the Kusum Yojana. Farmers should be made familiar with the different components of the Kusum Yojana. Places where it is not possible to install solar pumps, solar segregation should be given importance.
Thirdly, the grid connected solar rooftop panels under the National Mission should be popularized. The infrastructure needed for it should be developed and maintained in the district.
Fourthly, attention should also be paid on the research and development of the solar energy sector in the district. Solar panels with technologies beneficial for the specifically for the district should be developed.

### 4.5.2 Biomass

The district has not witnessed much development in the biomass energy sector. The district needs to understand the benefits of biomass energy. Moreover the district suffers the problem of stubble burning, which could be easily overcome by the biomass plants. For this the district needs to develop a well-connected system of transportation and accordingly storage centers should be constructed so the new entrepreneurs could pay more attention and invest capital in setting up biomass energy units. The rice mill owners should be encouraged to set up biomass energy plants so that they could utilize the waste produced. They can also collect the other agricultural waste from the villages which supply them with rice. Moreover the villages in the district can install their own biomass plants, if provided with the financial assistance by the government. This would increase the employment opportunities in the district. The steps should be taken according to the requirement in the different regions of the district.

**PROJECTION AND MONITORING MATRIX**

Firstly the people of the district should be made familiar with the biomass energy and the different policies government has made in this regard.
Secondly it is also important that people become aware about the demerits of stubble burning and understand that how can they alternatively extract energy from the agricultural waste instead of burning it.
Thirdly a well-connected system of transportation and accordingly storage centers should be constructed.

Fourthly, the native, especially the new entrepreneurs should be encouraged to set up biomass energy plants in the district. Also the villages can install their own biomass energy plants if provided with the subsidy by the government.
Lastly, the rice mills and other biomass producing industrial centers should be encouraged to set up biomass plants and specific provisions should be made for them in the district.

### 4.5.3 Biogas

Most of the population's incomes depend on agriculture and livestock. The waste from these sectors can be used to generate biogas with the help of the biogas plant. Government should build centralized biogas plants in the city and educate local people to install household biogas plants.

### 4.5.4 Hydropower

Harivanshpur and many other villages in Bihar's Vaishali district are flooded by knee-deep water. Many dams and reservoirs are built entirely or partially to help with flood protection and control. Many big dams have flood-control reservations, which require reservoir levels to be kept below a specific height prior to the rainy/summer melt season to provide a certain amount of space in which floodwaters can fill. Dam-created reservoirs can also be used to generate hydroelectric power, save water, and provide recreational opportunities. Government should construct these dams to prevent flooding and produce electricity.

# 5 RECOMMENDATIONS

### 5.1. Agriculture and allied sectors

- Salt-tolerant crop varieties should be used by the farmers in the salt-affected areas.
- The district has huge scope to adopt drip and sprinkler irrigation systems, mostly for vegetable and fruits cultivation.
- Resource conservation technologies like zero tillage for wheat and maize and mulching for vegetables should be practiced by the farmers.
- Organic farming should be adopted by the farmers to boost soil health under the government's schemes.
- Training to prepare the Vermicomposting and Green manuring should be organized to the motivate the farmers.
- The district has a huge scope for fruits cultivation like mango, litchi, banana, which should be encouraged.

- Inter-cropping like foot yam or turmeric cultivation in orchards should be practiced by the farmers.
- There is a need for infrastructure for fruits processing units for pickle and fruit juice especially for mango, litchi and banana.
- Farmers should be trained on the uses of fertilizer and chemical pesticides applications.
- The district has scope for introducing medicinal crops like mentha, tulsi, ashwagandha etc. which could be encouraged through proper training.
- There is scope for flower cultivation especially for marigolds, which should be encouraged among the farmers.
- Mushroom farming and bee keeping have huge scope due to their higher market access, small and medium scale entrepreneur, which should be encouraged on a large scale.
- The district has a huge scope for commercial greenhouse and polyhouse farming, particularly for nursery seedling and vegetables like tomato, cauliflower, capsicum etc.
- The district has huge scope to export high-quality cauliflower seeds to nearby districts and states.
- The farmers of the district should follow the weather forecast and the crop advisory for flood-affected areas.
- The district has a scope for the fishery, which should be encouraged.
- There is scope for the dairy processing units, this could be encouraged through training and providing market access for milk purchasing.

**5.2. Forestry**

- Vaishali District is forest deficient area with only 5.5% of forest area.
- The district has some popular tourist places. These places can be focused for afforestation drives.
- The trees in the afforestation drive should be fruit yielding or medicinal and aromatic plants. In this way the locals can earn and increase their livelihood options,
- District has 0% very dense category of forest. These forests are important for carbon sequestration and ecological balance in the local area. Local government should focus on dense groves of native trees to balance the flora and fauna. Agro-forestry and afforestation on barren and unused government lands, and land adoption to the local people to increase income and to provide the incentives to the guards and government can be the better option.

**5.2.1. Biodiversity**.

- It is recommended to conduct an afforestation program in the district by giving incentives to local people.

### 5.3. Tourism

### 5.4. Wetlands

The wetlands need to be intact, but at the same time, they need to be planned wisely to support the district economically, socially and environmentally, which will lead to indirectly relieving of stress from the Ganga River to a large extent. It will also lower the local people's dependence on the Ganga River for their small-scale industry or basic daily needs. The following recommendation and interventions are required to get valuable products and solve the issues/ challenges faced by the local people of that region.

- Introduction of improved cultivars and production technologies for pulses and oilseeds.
- Diversification through introducing vegetable, mushroom, beekeeping, fruits, medicinal plants, dairy, poultry etc. for nutritional security
- It is recommended to rejuvenate and restore the water bodies of the district.
- It is recommended to promote eco-tourism in the region as the region can develop with flower gardens around the wetlands area and biodiversity by creating a market for selling handicrafts nearby.

### 5.5. Energy

#### 5.5.1. Solar

- Awareness is the primary step that should be taken to develop the solar energy in the district Vaishali.
- Kusum Yojana should be popularized and farmers should be told about how they can benefit from it.
- Off-grid connections in remote areas should be provided with some financial help, this will incline more and more people towards renewable green and clean energy.
- If taken proper steps then solar energy can aid the farmers and the small industrialists to flourish.

#### 5.5.2. Biomass

- The people of the district should be made aware about the demerits of stubble burning and should be made acquainted with the biomass energy.
- The district extensively cultivates rice and wheat and hence Biomass based gasifier power project and Biomass based Co-Generation Power Project will be very beneficial for the district.
- Provisions for installing biomass plants should be made for the rice mills in the district.
- The biomass plants should be installed on the local level, like individual villages can establish their own biomass energy plants.

#### 5.5.3. Biogas

- Biogas plants and its benefit should be taught in schools, and awareness should be spread by making posters or pamphlets.

### 5.5.4. Hydropower

- It is recommended to identify a small hydropower project site near village Harivanshpur of capacity 1-2 MW.

## 6. Discussion during the Report Presentation

- NYKS volunteers are very active in Patna
- Natural Farming is being promoted among the farmers. Namami Gange will be contacted for the required training.
- Vaishali has a great historical heritage which has a great opportunity to attract tourism.
- Arth Ganga Trails will be explored.
- The suggestions by the Advisor, NMCG were noted
- Officials assured that the reports of the IIM-IIT consortium will be discussed in future DGC meetings.
- Regular Aarti at the Ganga Ghaats will be planned.
- The IIML Report for Arth Ganga should be a regular Agenda item for next 6-8 DGC meetings.
- Hon'ble PM during the post-Budget webinar on Tourism had spoken about market potential of destination weddings. It was suggested that suitable Ashrams in Ganga Basin may be identified for such purpose to promote blissful experience, cost reduction, livelihood opportunities and better upkeep.
- Allocate separate space for Namami Gange Awareness and Jalaj Marketing kiosk in Melas/Congregatios/Fairs for providing better marketing opportunities to the Jalaj products.
- As Dilli Haat Centre – Namami Gange Awareness and Marketing Centre – is being launched soon, it was requested that every district to identify niche products with a creative story and link it with Jalaj in their area.
- To identify Arth Ganga Tourist Trails and organize Ganga Guide training
- Promotion of Natural Farming in Ganga Basin and training workshops should be organized on a regular basis. NMCG is supporting this initiative in coordination with MoA& FW and NCOF.
- Make plans for reuse of treated waste water for agriculture, industrial etc. purpose and also the sludge.
- Training of volunteers for Ganga awareness & Aarti workshops to promote regular aartis on Ghats.

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# 6 APPENDICES

*Table 2 Biogas potential from animal waste.*

| Livestock | Residue type | Total population as of 2012 | Manure yield* (kg/day) | Total manure generation annually (kg) | Average collection (75%) | Dry manure after removing Moisture content | Manure required for biogas* (kg/$m^3$) | Biogas potential ($m^3$/yr) |
|---|---|---|---|---|---|---|---|---|
| **Cattle** | Manure | 212876 | 10 | 77,69,97,400 | 582748050 | 116549610 | 25 | 4661984.4 |
| **Buffalo** | Manure | 169101 | 15 | 92,58,27,975 | 694370981.3 | 138874196.3 | 25 | 5554967.85 |
| **Sheep** | Manure | 1716 | 1 | 6,26,340 | 469755 | 93951 | 25 | 3758.04 |
| **Goat** | Manure | 299125 | 1 | 10,91,80,625 | 81885468.75 | 16377093.75 | 25 | 655083.75 |
| **Pig** | Manure | 1695 | 2.5 | 15,46,688 | 1160015.625 | 232003.125 | 25 | 9280.125 |
| **Poultry** | manure | 48,112 | 0.1 | 17,56,088 | 1317066 | 263413.2 | 25 | 10536.528 |
| **Total** | | **7,32,625** | | | | | | **10895610.69** |

*Table 3 Biogas potential from agricultural waste.*

| Crop | residue type | Total crop production (tons) (2017-18) | Residue production ratio | Residue amount (tons) | Average collection (70%) | Moisture content | Residue amount after removing moisture (tons) | Biogas potential [m3/(tons of dry matter)] | Overall biogas potential (m3) |
|---|---|---|---|---|---|---|---|---|---|
| **Maize** | straw | 85199 | 1.5 | 127798.5 | 89458.95 | 15 | 76040.1075 | 800 | 60832086 |
| **Wheat** | straw | 115400 | 1.5 | 173100 | 121170 | 30 | 84819 | 800 | 67855200 |
| **sugarcane** | bagasse | 9935 | 0.33 | 3278.55 | 2294.985 | 80 | 458.997 | 750 | 344247.75 |
| **Total** | | **210534** | | | | | | | **129031533.8** |