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POLICY Brief

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Shrimp, Salinity and Sustainability– An Assessment from Southern India

Shrimp farms are a key part of the regional economy in India and many other parts of Asia. However, the industry is known to cause soil salinization, which can affect the productivity of surrounding croplands. In this study, a team from southern India carefully examines the shrimp-farming related salinity problem and estimates the economic impact that shrimp farming has on farmers' livelihoods. The study, which is the work of a research team from the Pandit Jawaharlal Nehru College of Agriculture and Research Institute, assesses two villages in the district of Karaikal, one that is affected by shrimp farms and the other that is not. The study finds that soil salinity caused by shrimp farms has a significant negative effect on paddy yields.

This study concludes that farms with highly saline soils would gain significant economic benefits if soil salinity is reduced to safe levels; if this were done the gains could range from Rs 1,000 to Rs 5,000 per hectare. In light of these findings, the study recommends that a Farmer's Irrigation Society be set up in affected communities to help farmers manage soil salinity through measures such as rainwater harvesting, the application of appropriate chemicals and the maintenance and regulation of sluice gates. It also recommends that a regulatory framework be developed to help farmers affected by salinity and to bring long-term sustainability to their agricultural efforts.

BIG BUSINESS, BUT BAD FOR THE ENVIRONMENT?

Shrimp farming is important in a number of coastal regions of India. It accounts for about two-thirds of exports of marine products (shrimp is exported to Japan, USA, Europe and elsewhere), and the sector earns foreign exchange worth about Rs 8,348 crore (US$ 1.61 billion) a year. Shrimp cultivation takes up an area of almost 200,000 hectares - largely in the states of Andhra Pradesh, West Bengal, Kerala, Orissa, Maharashtra and Tamil Nadu. Shrimp production has grown steadily in recent years – expanding in both acreage and production by over 8 per cent a year.

While the short-term financial returns from shrimp farming are high, it does, unfortunately, have significant environmental impacts. The use of sea water for shrimp cultivation can cause the salinization of soil and groundwater and this can affect the productivity of agricultural crops in surrounding land. This means that for many coastal communities, which depend on a mix of agricultural activities, shrimp farms can be a big problem. Loss of coastal mangroves is another concern associated with shrimp farming. There is already legislation in India to reduce the negative impact of shrimp farming, but this is only rarely enforced. This is why the country's forthcoming Aquaculture Authority Bill is of concern to many environmentalists. If approved, the bill will give legal status to the industry and promote large-scale growth of shrimp farming in India.

SCRUTINIZING THE PADDY IMPACTS OF SHRIMP FARMING

To help find a solution to this environmental and economic challenge, this study looks at the environmental issues surrounding shrimp farming. In particular, the study asks: What is the impact of the soil salinization caused by shrimp farming on paddy productivity? This question is answered by carefully comparing paddy yields in two similar villages in southern India: The first of these is Poovam, which is close to a number of shrimp farms clustered

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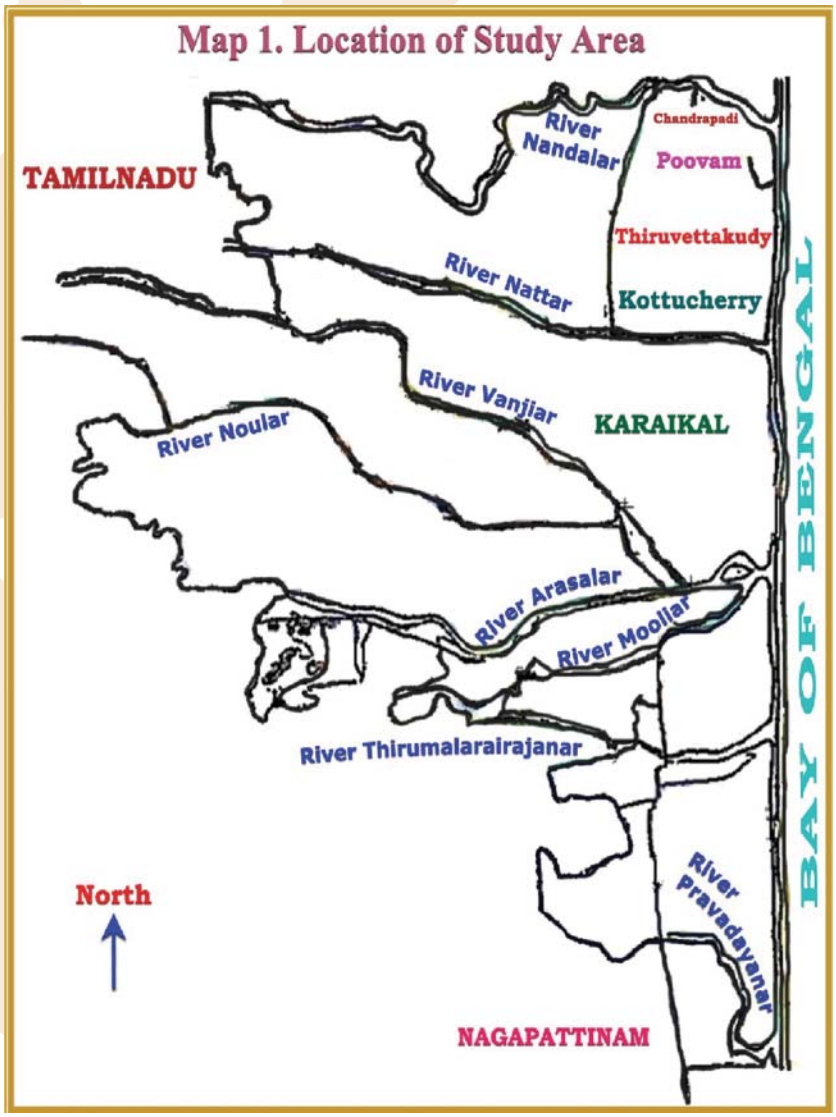
around the village of Chandrapadi; the other study village is Thiruvettakudy, which lies adjacent to Poovam, but is physically separated from the shrimp farms.

The shrimp farms in Chandrapadi are located on the Tamil Nadu-Puducherry boundary. The impact of this shrimp farming on cropland in the area has become a vexed issue in recent years. Paddy is the major crop cultivated in the region and many rice farmers are concerned about the negative effect of shrimp cultivation on the productivity of their farms and on their livelihoods.

SHRIMP AND PADDY CLUSTERS

There are 14 shrimp farms clustered in the north-eastern part of Chandrapadi. They lie along the Nandalaru tributary (close to where it joins the Bay of Bengal) and have a combined pond area of 65 ha. This shrimp farming area was chosen for the study because: (i) paddy fields are located nearby; (ii) the shrimp cluster has been in use for a long period; (iii) there are no other shrimp farming clusters in the neighbourhood (which removes the possibility of overlapping salinity effect on paddy fields); and (iv) time-series data on soil characteristics and cropping details was available.

Shrimp is cultivated during the summer (February to June) and during the monsoon (October to January) seasons. Summer is the major growing season, with high production because of high salinity levels. The second crop coincides with the northeast monsoon and production is lower as rains dilute the salinity in shrimp ponds. This is the time when sea water is pumped into shrimp farms to raise salinity. This leads to the intrusion of soluble salts into aquifers and salinity build up in surrounding soils.



Over the last two decades the region has seen several changes in shrimp farming methods in response to multiple disease outbreaks. Currently, the modified extensive and semi-intensive methods of shrimp farming are practiced. Although shrimp farming is the predominant agricultural activity in Chandrapadi, rice paddy is the major crop cultivated in Poovam and Thiruvettakudy. It is grown during the 'samba' season and is rotated with gingelly or black gram. Paddy farmers from both villages depend on canal water as the major source of irrigation, although the supply from the canal is very erratic as both villages are located at the tail end of the deltaic zone.

Poovam village has 200 households – some 85 are farm households and others are wood traders and agricultural labourers. The land holding

per household is 1.27 ha and fallow land accounts for 29 per cent of the total land area. Thiruvettakudy is more than twice the size of Poovam in terms of population. Paddy accounts for 88 per cent of the gross cropped area and land holding per household is 2.08 ha.

COMPARING THE PRE- AND POST SHRIMP PERIODS

To assess the impact of shrimp farming, the research team first checked to see whether the two study villages (Poovam and Thiruvettakudy) had been similar before shrimp farming started in the region. To do this, they examined secondary historic data on soil salinity, land use and cropping characteristics collected from various government projects and agencies.

To assess the current situation, primary data from paddy farmers was collected through interviews with 165 households covering 257 farmland fragments (parcels of land). Of the total sample, 55 farms and 48 fragments were from Poovam and 110 farms and 209 fragments were from Thiruvettakudy. Information was collected on farmers' income, their use of fertilizer, the costs and returns they get from paddy cultivation and their attitudes towards shrimp farming. Soil data was also collected from the two villages and the soil was assessed to measure its salinity. The electrical conductivity (EC) of soil gives a measure of salinity. An EC value of less than 1 indicates that soils are highly suitable for cultivation, whereas EC values between 3 and 4 indicates that soils will not produce an optimal yield. Soils with an EC value more than 4 are designated as saline soils and need reclamation to restore them for cultivation.

The historical data collected shows that soil salinity was normal in both Thiruvettakudy and Poovam villages before shrimp farming started in the area. At this time, the villages' irrigation system was similar and so was the ratio of their farmed and unfarmed land. Thus, although Thiruvettakudy is nearly twice the size of Poovam, in terms of cropping patterns the two villages were similar.

THE IMPACT OF SHRIMP FARMING ON AGRICULTURE

The more recent soil samples taken from cultivated lands and fallow lands in Poovam showed a wide variety of salinity levels (EC values). In the lands adjoining shrimp farms, the mean EC level is very high and ranged from 4.95 to 15.89, while cultivated lands have an EC range of 0.02 to 3.0. In comparison, an analysis of soil samples taken in Thiruvettakudy showed that soil salinity in this village is in the normal range. This suggests that shrimp farming can lead to increased salinity in cropland.

When the yields and returns that farmers are getting from their land was assessed, the researchers found a big difference between the two villages. In the case of transplanted paddy, on average, Thiruvettakudy farmers get net returns of Rs 6,265 per hectare, while Poovam farmers make a loss of Rs 5,400 per hectare. Such losses are un-sustainable and have already forced a few farmers in Poovam to sell their lands. The significant difference in economic returns is primarily accounted for by the large gap in the productivity of paddy fields between the two villages. In Thiruvettakudy the yield is 3,973 kg per hectare, which is 87% more than Poovam's 2,124 kg per hectare. The situation is not much different when direct sown paddy is considered.

THE COSTS OF SALINITY AND THE BENEFITS OF IMPROVEMENT

When the causes of paddy productivity are assessed it is observed that there is a definite link to soil salinity. Salinity has a negative and statistically significant influence on paddy yield. It is found that a 1 per cent percent increase in EC produces a 0.063 percent decrease in paddy yields.

Because salinity is causing a decline in crop productivity, it is clear that farmers in Poovam will benefit from a reduction in soil salinity to safe levels. Information from the cropped areas in Poovam show that the maximum salinity level in the village's soil is 3. If this soil was desalinated it would produce an average gain of between Rs 1,000 to Rs 5,000 per hectare. This average gain is based on an increase in yield of 172 to 836 kg per hectare. While many farms have not reached this level of salinity, there is a significant likelihood that they will in the future. This is because they continue to be exposed to the shrimp farms that are adjacent to their village.

SANDEE

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Gains per hectare from reducing salinity to safe levels based on different methods of estimating paddy productivity.

Estimate	Per hectare land productivity (Mean EC=1 in dS m^{-1}, which is considered safe	Per hectare land productivity (Mean EC =3 in dS m^{-1}, which is considered high	Gain per hectare (kg) by salinity reductions to safe levels (column 2-3)	Gains per hectare by salinity reductions to safe levels (Rs)
I	2	3	4	5
I	2582	2410	172	1008
II	2681	2540	141	826
III	2557	1721	836	4899
IV	-	-	1647	9651

Note: Estimates I, II and III use regression results with different paddy production function specifications. Estimate IV is obtained by comparing farm productivity of affected and unaffected villages. Gains in Rs are calculated by assuming an average paddy price of 5.86 per kg.

HELPING THE FARMERS TO HELP THEMSELVES

What can be done to help farmers in Poovam reduce the salinity of their soil and so help them get better returns from their farms? One answer can be found in Thiruvettakudy, where the farmers are all members of the Farmers Irrigation Society (FIS). This society has the responsibility to maintain canals and temple ponds, to regulate canal water supply and to adjudicate disputes between farmers. The FIS has also helped farmers to resist the establishment of shrimp farms in their village.

This institutional model could serve the farmers in Poovam and could also be established in other agricultural communities in the coastal tracts of Tamil Nadu and Puducherry. An FIS could help farmers affected by shrimp farms to implement salinity control measures like rainwater harvesting, the application of amendments like gypsum based on soil tests, the maintenance and regulation of sluice gates and leaching and drainage. Regular monitoring is another critical step that must be taken to prevent an increase in salinity over the long term, and this will require frequent and regular soil testing by the authorities.

One further step that could be taken is to get the region's shrimp farmers to pay, in some way, for the increased land and water salinity they cause in their neighborhoods. A variety of economic instruments, such as taxation, exist to do this. If such economic measures could be implemented, it would be a way to help reduce the problem, provide resources to pull affected farmers out of the cycle of loss they are trapped in and bring long-term sustainability to agricultural practices.