SUSTAINABILITY OF INDIAN AGRICULTURE: A "TRIPLE BOTTOM LINE" APPROACH

Asst. Prof. Manabhanjan Sahu, *Faculty Dept. of Humanities PMEC, Sitalapali & Research Scholar (B.U)* [1]
Prof. Dr. Jitendra Kumar Sahu, *Mech.HOD and Head T&P office SMIT, DEC, Chandipadar.*[2]
Mail IDs: sahumana@yahoo.co.in[1] *sahujitu70@gmail.com*[2]

ABSTRACT:

With increase in family size and reduction in average agricultural land area agricultural sustainability is difficult to be maintained. Hence by the approach of mixed cropping it allows the subsidiary crops to join the base crop to achieve a sustained agriculture.

It is a fundamental research mainly concern with formulation of the theories for attaining a sustainable agriculture by addition of subsidiary crops to the pre existing base crop. The information is collected from the secondary data, and for analysis the statistical tools used are simple arithmetic calculations. The researcher in this paper presented a descriptive analysis and diagnostic study of how much land from the base crop shall be allotted to the subsidiary crops so that the productivity of main crop is retained. And also the each of the subsidiary crops shall contribute the same amount what the base crop is providing, so that the farmer shall never be in a position of gross loss. Further the researcher has taken a real time example of three different types of crops in a mixed cropping strategy, and the same is also presented in a pictorial form for batter understanding.

Key words: base crop, subsidiary crop, mixed cropping, sustainable agriculture.

INTRODUCTION:

"Bottom line" is a commercial term representing the informal expression of Net income or statement of income from a business operation. Traditionally the in business accounting it refers to either the "profit" or "loss", which is usually recorded at the bottom line on a statement of earnings or losses.

The term "triple Bottom Line (TBL)" was first coined by Freer Spreckley (UK) in his publication "Social Audit – A Management Tool for Co-operative Working", is an international development consultant on social enterprise and social economy in 1981. It is more elaborated by John Elkington in his book "Cannibals with forks: the triple bottom line of 21st century business.

Here in this paper the bottom line refers to the three basic components of agriculture which may give an earning to the farmers. Reason behind giving three bottom lines is that, if any of the components fails in making profit then rest two can compensate the losses. The same is applicable if any two makes a losses then the third could contribute a compensative recovery, so that the overall profitability is maintained or losses to be reduced to a compensate level.

OBJECTIVE OF THE STUDY:

India being an agrarian country where 60% of the people depends on agriculture on agriculture allied services with average agricultural land size is 1.16 hectors, the farmers and farm labors are technologically incompetent to increase the crop productivity from the existing farm.

The cases of suicide related to agriculture are due to failure of agricultural crop and financial insolvency.

The objectives are.

- To analyze the problems related to agricultural small land holdings.
- To find out the Causes of farmer suicide in India
- To suggest the best course of actions which may improve the agricultural productivity
- To present the best model of mixed farming without disturbing the existing farming.
- To reduce food loss and food wastages.
- To attract the investors and maintain a sustained agriculture.

RESEARCH METHODOLOGIES:

It is a fundamental research, where the researcher did a descriptive as well as a diagnostic analysis of those data in detail.

The data collected is from different secondary sources, like books, magazines, literature, published papers, on-line study materials, websites, annual reports, articles, financial statements, newspapers etc. the same is analyzed by using simple arithmetic statistical tools.

The researcher designed his own model of mixed agriculture in multi-storeyed structure, and finally he presented a pictorial for of the model so that one be more clear about the model.

REVIEW OF LITERATURE:

As a report in The Wall Street Journal points out: "India is the second largest producer of rice and wheat after China, with China producing about 40 percent more rice and wheat than India. India is also the second largest producer of fruits and vegetables in the world after China, but China's fruit production is three times India's production."

What this tells us is that India's agricultural productivity is low compared to that of China and many other countries in the world.

A report from the Food and Agricultural Organization 2013 points out: "India produces 106.19 million tonnes of rice a year from 44 million hectares of land. That's a yield rate of 2.4 tonnes per hectare, placing India at 27th place out of 47 countries. China and Brazil have yield rates of 4.7 tonnes per hectare and 3.6 tonnes per hectare, respectively."

In case of wheat the productivity is better than that of rice. "With 93.51 million tonnes of wheat from 29.65 million hectares, India's yield rate of 3.15 tonnes per hectare places it 19th out of 41 countries. Here, we do better than Brazil's yield rate of 2.73 tonnes per hectare, but lag behind South Africa (3.4 t/ha) and China (4.9 t/ha)," the report points out.

The State of the Indian Agricultural Report for 2012-2013 points out that: "As per Agriculture Census 2010-11, small and marginal holdings of less than 2 hectare account for 85 percent of the total operational holdings and 44 percent of the total operated area. The average size of holdings for all operational classes (small & marginal, medium and large) have declined over the years and for all classes put together it has come down to 1.16 hectare in 2010-11 from 2.82 hectare in 1970-71."

GLOBAL CROPPING PATTERNS:

- **Sequential or rotational cropping:** It refers to growing of different crops in recurring succession on the same field of land in a specific period of time. It is divided into
  - **Single cropping:** it refers to the growing of only one crop on a piece of land year after year e.g. rice
  - **Multiple cropping:** growing of more than one crop on a same field of land in a recurring succession in one calendar year. The main objective is to obtain maximum production per unit time per unit area. This is further sub divided into
    - Double cropping: growing two crops on the same piece of land in a recurring succession in one calendar year.
    - Triple cropping: growing three crops on the same piece of land in a recurring succession in one calendar year.
    - Relay cropping: it is analogous to relay race where a crop hands over the land to the next crop in quick succession.
- **Inter / mixed cropping:** Growing of two or more crops simultaneously on the same area of land in a definite row arrangement. In this cropping there is a greater utilization of interspaced area, the spatial distribution of light, nutrients, moisture, air and microenvironment of both rhizospheres and phyllospheres and the temporal use of the resources during slow grown phase of crop by subsidiary crops. This is of following types
  - **Intercropping in additive series:** The inter-crop is adjusted between recommended space of the base crop in alternate (one component crop or main crop)
  - E.g. sugar cane + wheat, sugar cane + potato, sugar cane + mustard etc.
  - **Inter-cropping in replacement series:** few row or plants of one component crop are replaced by few rows or plants of another component crop by a ratio.
  - E.g. Potato + mustard (3:1), potato +wheat (3:3), wheat + mustard (9:1) etc
- **Inter-cropping in both series:** both the inter-cropping system is included. It is further divided in to four groups' i.e.
  - **Parallel cropping:** two crops are selected having different habits and zero competition between them e.g. black gram or green gram with maize.
  - **Companion cropping:** the yield of the both crops is equal to their pure crops (any single one) e.g. sugar cane + wheat, sugar cane + mustard.
  - **Synergetic cropping:** the yield of the both crops grown together is higher than their pure crop e.g. sugar cane + potato.
  - **Multi-storeyed cropping:** growing of plant of different heights in the same field at same time e.g. eucalyptus + papaya + berseem, sugar cane + potato + onion, sugar cane + potato + mustard etc.

SUSTAINABLE AGRICULTURE:

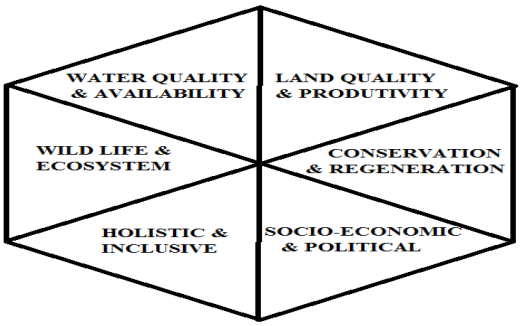
In general term Sustainability (sustain and ability) is the process of endurance of systems and processes. When we speak about sustainable development it is more or less concern about four inter-connected environments, these are ecological, economic, political and cultural environment.

It is in lime light since the 1980s when Brundtland Commission of the United Nations on March 20, 1987 defined it as "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". And officially the "Agenda 2030 for Sustainable Development" was adopted on 25 September 2015 which gave out 17 Sustainable Development Goals and it 169 targets to be achieved by 2030. It succeeded the Millennium Development Goals on 1 January 2016. Out of these seventeen goals the "Sustainable Agriculture" comes in second most priority goal (SDGs2) under the heading "Food" following Poverty and followed by Health.
Sustainable agriculture is performing agricultural activities in a sustained way, so that the economies are to be achieved and maintained without hampering the agricultural ecosystem and its environment.

Important components of a sustainable agriculture:

In the practice of agricultural activities the natural resources are directly in interaction with the human beings. These resources are of biotic and a biotic in nature. The biotic resources are all the living beings starting from big animals to micro-organisms through pests and insects. And the abiotic resources are all non living things e.g. land, water, air, fuel etc. the whole environment started degrade when a unsustainable agricultural practice is done by us, as a result the viability of future agricultural operations may at stake. Hence a sustainable agriculture premises that our resources shall be carefully managed so that the cultivation can last for a indefinite period. Beside the natural resources the other associated socio-economic and political environment also plays a greater role in the operation of a sustainable agriculture.
The following are the 6 most important components of sustainable agriculture.

Figure1. Representation of six inter-related components of a sustainable agriculture



Source: The picture is created and designed by the researcher

Water quality and availability:

The quality of water and its availability plays a major role in sustainable agriculture. Water quality refers to the purity of water, a chemically contaminated water cannot help in sustainable agriculture, in reverse sustainable agricultural practice don't allow the water to be contaminated by excess use of harmful contaminants like harmful pesticides and nitrates. A sustainable practice always look at the availability side of water, accordingly it carefully choose the right seed and right time to make the cultivation profitable.

Land quality and productivity:

Land quality is directly related to the productivity of the land. Only a healthy land can give batter productivity, hence a sustainable agriculture always seek its land to be healthy to yield for an indefinite period.

Wild life and ecosystem:

Farming shall not deteriorate a natural habitat or a biodiversity of a region, otherwise changes in the natural habitat may have a direct negative impact on the productivity of the crops. Maintaining the biodiversity of local wildlife helps the crops in natural pest management and avoids the cost associated with the losses.

Conservation and re-generation of renewable energy:

Many a times the agricultural operations are dependent on non-renewable sources of energy e.g. petrol, diesel or coal etc. which causes global worming inhalation diseases. By using the renewable sources of energy e.g. Wind, solar and biomass the issues can be resolved.

Holistic and inclusive:

The holistic approach involves every farmer to participate in the mission of sustainable agriculture, hence as a whole community contributes to the economies of the farming. In the same way the inclusive development distributes the benefits to the last men in the community or society. Hence it reflects the humanitarian approach of a sustainable agricultural economy.

Socio-economic and political environment:

The social, economic and political environment influences the sustainability of agriculture. By establishing fair and clear labor laws, land acquisition laws, tax structure etc the agricultural sustainability can be maintained.

AGRICULTURAL PRODUCTIVITY IN INDIA:

Indian is an agrarian dominated economy, where agriculture and its allied services contributes around 14% of countries GDP and engaging around 60% of population in it. But its growth rate is mere just 4% as compared to the other sectors nearing double a digit figure and overall growth of 7.3% in 2014-15.

As per the data from World Bank, around 60 percent of India's land area is agricultural land. The bank defines agricultural land as "share of land area that is arable, under permanent crops, and under permanent pastures." Hence 60% of Indian land mass are under agriculture, it may be a monoculture or may be having a multiple cropping style

India is having the second largest agricultural land in the world after USA, this says that we have enough land dedicated to agriculture and even if any sort of seasonal non agricultural land happens, we still have enough land left for agriculture. So there shall be no bigger problem related to availability of land for agriculture in India.

In the contrary take the case of China, this has less agriculture land as compared to India. The total arable land in china is only a little over 34 percent that of its total land size, still it produces more rice and wheat than India does.

FARMER SUICIDE IN INDIA:

As per the report of National crime record bureau of India 2014, a total of 5650 farmers did suicide as per the official record. The highest being 18241 farmers in the year of 2004. The reasons are may be of a single or multiple factors, but the centre of argument is the failure of crop and financial loss from the agriculture. There are multiple pre and post harvest factors and these are as follows.

- Insufficient or no rain related to monsoon
- Improper and insufficient irrigation facilities
- Natural calamities like Drought and flood etc.
- Economic policy and assistance from Government.
- Expenses related GM (Genetically Modified) crops and its failure.
- Financial loss and financial burden.
- Small agricultural land or land less farmers.
- Insurance coverage and on its settlements pattern.
- Recovery pattern from private lenders.
- Rate of interest and conditions of repayment.
- Personal, family and social issues.
- Post harvest storage and selling issues.
- Failure of debt relief schemes.
- Extreme dependency on monoculture (single crop).

SUBSIDIARY CROP APPROACH TO A SUSTAINABLE MIXED AGRICULTURE:

The practices of monoculture accompanied with lack of proper inter/mixed-cropping knowledge and post harvesting assistances (storage, processing, distribution and sales), the productivity of Indian farms is comparatively low in comparison to other developer/developing countries.

Even though some of the farmers do the practice of inter/mixed cropping, the quantity of the subsidiary crop is too less that it could hardly attract any marketing or processing industry to it. As a result the farmers are getting their deserve price in right time, and ultimately this may lead to the wastage of food crop.

ANALYSIS AND INTERPRETATION:

There are multiple reasons why a farmer makes losses from the agriculture; hence they need to have multiple sources of income from a agricultural land throughout the year so that the losses from the main crop can be substantially recovered by subsidiary crops.

The researcher in this paper tried to divide the agricultural year in to three different periods as per three different types of crops.

1. A perennial crop plant which produces thought the year or multiple times in a year.

2. A cash crop or a catch crop to explore and enhance the financial gains in short period i.e. a short cultivation period of 30 to 40 days.
3. The base crop on which the land is being practiced since from his/her ancestral period.

These are the three bottom lines on which the farmer can be assured of a profit in gross. Now the question is what shall be the proportion of land shall be assigned to different crops in a mixed cropping system.

Because one cannot be hundred percent sure about the agricultural productivity, the analysis is done on the base of average production and average selling price at present.

To make it vigilant the researcher in this paper has taken the examples of the mango tree as the perennial crop plant, mushroom as the cash crop and rice as the base crop.

The average land size of the Indian farms is 1.16 hector (1160 m^2), if it is square size then it would be measuring as 34.05 m X 34.05 m in length and breadth respectively.

Productivity from Rice:

The average production from a hector of land in India is 2400 kg (2.4 tonnes) of rice annually and the average whole sale price is Rs.20 per kg. Hence in monetary terms it is Rs. 48000 per annum per hector of a land.

This is the base line for the farmers which he/she wants to protect to survive in agriculture.

Now to analyze what proportion of this agriculture land shall be allotted to other farm activities so that, this productivity is protected or least affected. The target is Rs. 48,000 per annum.

Productivity from oyster mushroom:

One square meter of oyster mushroom produces 10 kg of mushroom, and price for 1 kg of it is around Rs.40 per kg. Hence one square meter of shade can give revenue of Rs. 400 per cultivation and there are six such individual cultivations in a year becoming Rs.2, 400 per annum per shed in a 1 square meter area. So get revenue of Rs.48, 000 it requires only twenty square meters. This comes around 1.72 (round to 2) % of the total agricultural land; hence have a no impact on agricultural land of base crop.

Productivity from the mango trees:

From 4^{th} to 5^{th} year onwards a hybrid mango tree starts giving fruits at the rate of 100 kg of mangos per year. From 10^{th} year onwards till 40 to 50 years the quantity increases to 400 to 600 kg of fruits, and then it declines. So on an average 400 kg of fruits per plant and price per kg of mango is Rs. 20. Hence the total productivity from a single tree is Rs. 8000 per annum.

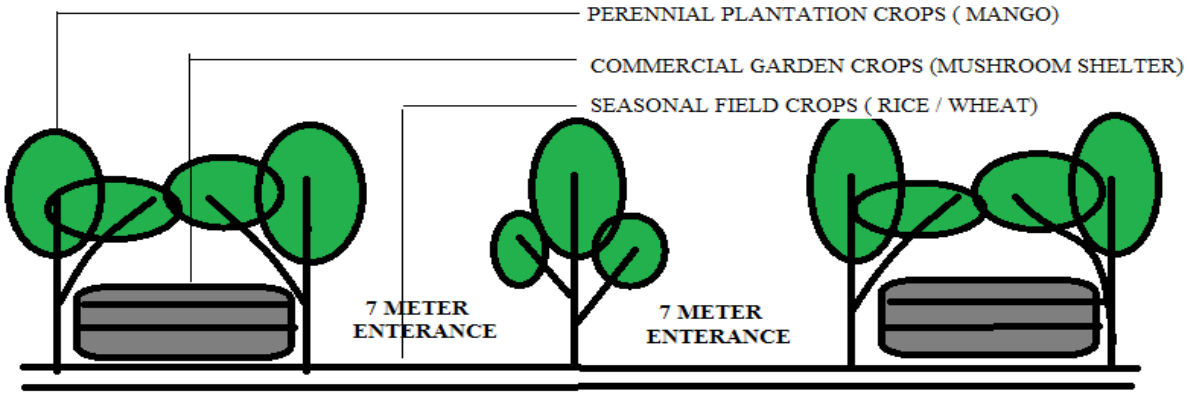
To get the revenue of Rs. 48,000, a farmer need to plant six trees in his/her agricultural field. This is quite possible because the land size is 34 x 34 meter, and a general gap between the mango trees shall be of 6 to 7 meter. In difficult situation at least five trees can be planted which may give revenue of Rs.40, 000 per annum.

This is further encouraging because there shall be no extra land required for planting the trees beside the mushroom sheds. Because mushroom sheds need a dark and moist environment, hence the sheds can be built under the mango trees. There will be a symbiotic relation between the mango trees and mushroom sheds as moisture given to the mushroom are absorbed by mango trees, hence a partial irrigation is naturally available and mushroom sheds naturally get a shed under the leafy vegetation of mango trees.

In short, out of the total land of 34 meter length and 34 meter breadth, only meters shall be carved from the entrance or at the end of the agricultural land for mango and mushroom cultivation. This has to be followed by all the farmers in that locality in a holistic approach. Because individually a single farmer may not attract a processing or marketing industry, but as a whole the cumulative production of specific crop will obviously attract them. Moreover the farmers can control over the price of the agricultural crops and they can enjoy business sustainability in long run.

PICTURIAL PRESENTATION OF MULTI-STOREYED MIXED FARMING MODEL:

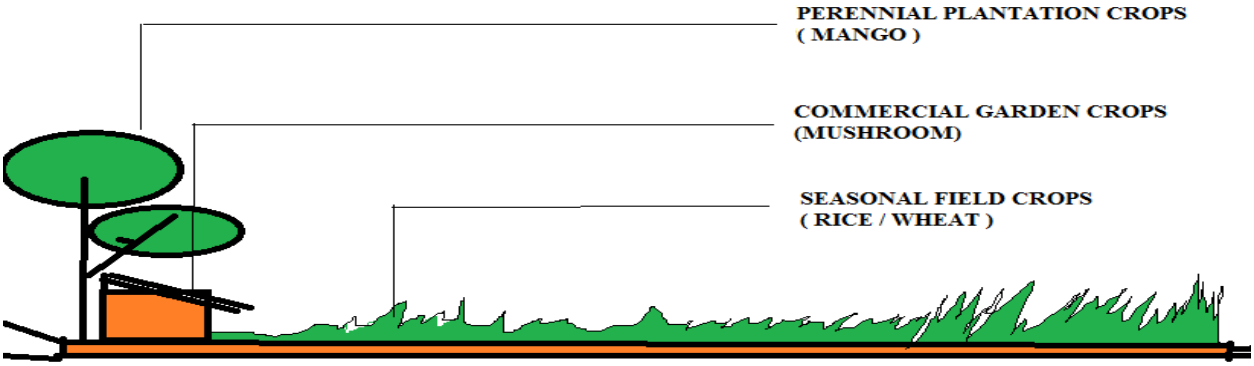
Picture1. Front view of multi-storeyed mixed farming.



MULTI-STOREYED CROPPING (FRONT VIEW)

The above picture represents the frontal view of multi-storeyed mixed farming, where the mushroom sheds each measuring ten meter in length and one meter in width on either side of the entrance. These two in total is 20 m^2, which is as per the calculation are under the shades of the mango tree. A single land 20 meter length and 1 meter breadth carved out from the beginning or at end of farm is used for both plantation of mango tree and mushroom shed. The total length was 34 meter, hence after deducting 20 meter from it the remaining is 14 meter left for entrance in to the farm, which is presented as 7 meter entrance on both the side of the tree at center.

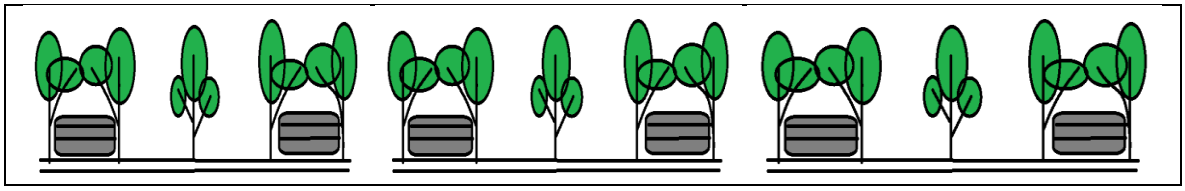
Picture2. Lateral view of multi-storeyed mixed farming.



MULTI-STOREYED CROPPING (LATERAL VIEW)

The above figure is a lateral view of the picture 1, the rest of the descriptions are same as the said picture. This picture clearly presented that tha mushroom shades are under the tree and sharing the same agricultural land area between them.

Picture 3. cumulative multi-storeyed mixed farming.



CONCLUSION AND RECCOMENDATIONS:

By diverting just 2 percent of land for subsidiary crops a farmer can earn as much as three times that of the base crop under ideal situation shall be a good option for them. The farmer can really make a substantial profit out of it. But the success story does not ends here unless the investors like marketing agencies, sellers, exporters or processing industries are attracted toward them. And also there shall be enough infrastructure facilities to reduce the food loss and food wastages associated with delays in dispatch. Hence there are two options for the farmers. i.e.

Either to attract them there shall be enough quantity so that the said industries feel that their purposes are fulfilled from a single geographical location, their break even shall be met from that specific region.

Or to create cold storage and all weather storage facilities near by their locality or a very fast transport facility for the perishables.

In both the situations either the farmers sells or process the crops directly or by a media, the prime factor is diversities in cropping pattern i.e. types of crop and timing of cropping and yielding.

If the same crops are grown by all the farmers then individually it may be a small quantity but as a whole from hundreds of farmers it shall attract every industry in to their locality and also convenient to create a storage facility.

The same is applicable for the timing of cultivation, if the timing are different then the gross quantity of crops may be divided in small quantities which may not be able to attract the industries, and having difficulties in storage.

SCOPE FOR FURTHER RESEARCH:

The researcher in this paper has done analysis for only three crops namely Rice with mango and oyster mushroom in a mix; this can be extensively calculated for other crop combinations.

There is a further scope to find out the size, type and location of industries to be established so that they can contribute for sustainable agricultural practices.

REFERANCES:

Websites:

http://indianexpress.com/article/opinion/columns/agricultural-policies-ill-equipped-indian-farmers-suicide-modi-government-2863359/
http://nhb.gov.in/report_files/mango/MANGO.htm
http://pib.nic.in/newsite/PrintRelease.aspx?relid=136922
http://thewire.in/23273/agriculture-sector-needs-more-than-just-income-security-for-farmers/
http://www.agrifarming.in/mango-farming
http://www.agrifarming.in/mushroom-cultivation
http://www.fao.org/docrep/004/Y0501E/y0501e03.htm
http://www.fao.org/docrep/004/Y0501E/y0501e03.htm
http://www.icar.org.in/en/taxonomy/term/156
http://www.tradingeconomics.com/india/gdp-from-agriculture
https://stirringthepyramid.wordpress.com/2012/03/10/farm-sizes-and-incomes-in-india/
https://sustainabledevelopment.un.org/?menu=1300
https://www.nal.usda.gov/afsic/sustainable-agriculture-information-access-tools

Books:

Dr. B.B Singh, IFS agriculture ,K. Siddhartha

Journals:

Carolyn Raffensperger and Nancy Myers, A Brief History of Sustainable Agriculture.
FAO," World Agriculture towards 2015/2030".
Frederick Kirschenmann (March 2004)" The Networker", vol. 9, no. 2,
Gold, M. (July 2009). What is Sustainable Agriculture?
Govt. of India, department of agriculture (2016) "Horticultural statistics at glance 2015"
McGill University, "Advances in Sustainable Agriculture: Solar-powered Irrigation Systems in Pakistan"
McKinsey&company (2014) "India's economic geography in 2025: states, clusters and cities".
McKinsey&company (2014) "understanding India's economic geography"