Underground Water Development in India – Trends, Crops

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Year 2005

"Water has the power to move millions of people, let it move us in the direction of peace"
Michael Gorbachev, ex-President of Soviet Union and Noble Peace Prize Winner.

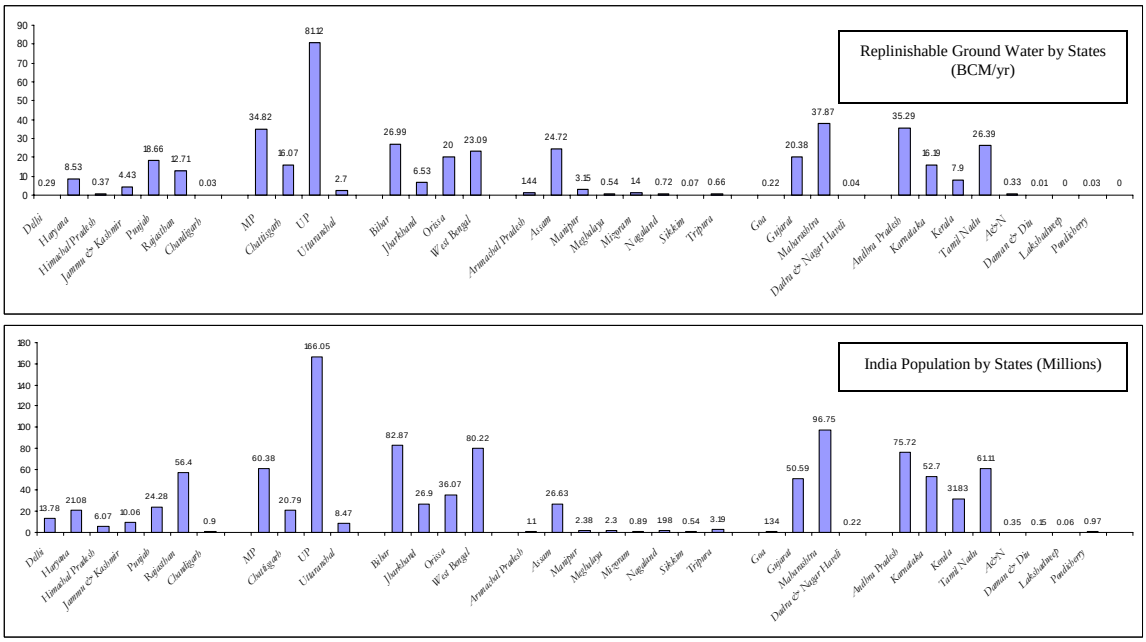
INTRODUCTION

Fresh Water is a basic requisite of life on mother earth, and is available in aquifers under the ground and on surface as rivers and lakes. The underground water generally is of high quality and requires little or no treatment to make it fit for consumption – one of the reason for its important role in human settlement from ages. With the rise in human population, more food consumption on a per person basis and continued global industrialization, groundwater today is the world's most extracted raw material and the deep extraction is credited to the advancements of drilling and digital mapping technologies. The global fresh water consumption has risen six folds between 1900 and 1995, which is more than twice the rate of population growth. For India, it is the cornerstone of Green Revolution that brought self-sufficiency in food grain production for the nation. Groundwater brought huge benefits to India due to better quality (minimal treatment), drought reliability (food security) and sustaining mega cities and major economic centers.

The initial objective of this study is to understand the current state of Underground Fresh Water Development in India and look at related emerging trends. This would further lead into the closer understanding of underlying problems and help deduce creative integrated solutions combining public policy and grass-root action. As water is a life force that may perish or flourish a Nation, we believe that it is critical to understand & take action on this for regional peace and prosperity of Indian Subcontinent.

UNDERGROUND FRESH WATER DEVELOPMENT IN INDIA

India's total annual replinishable underground fresh water is 433 BCM (Billion Cubic Meters) – 344 BCM through natural recharge from rainfall and 89 BCM from canal irrigation system. The in-storage ground water reserve for the country is approximately 10812 BCM. There are 12 major river basins, the largest is Ganga-Brahmaputra-Barak basin or Gangetic Plain Aquifer with replinishable ground water at 206 BCM or 48%.

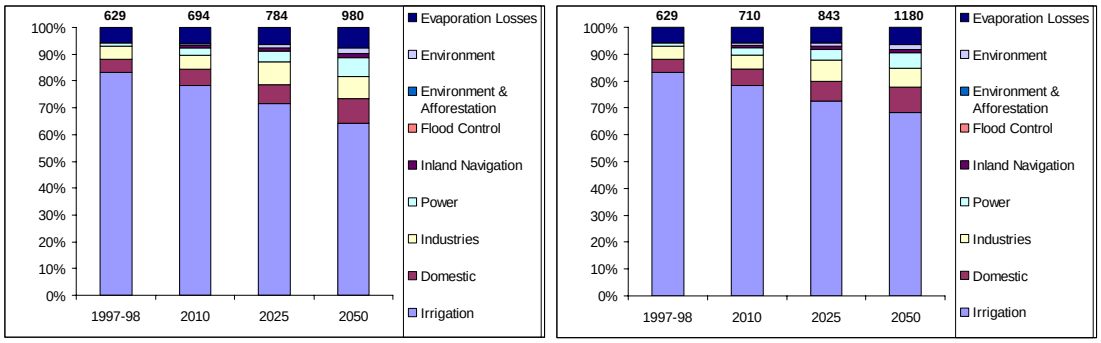


The two charts (last page) present the distribution of replinishable ground water and human population by 28 Indian States (Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Jharkhand, Goa, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Chhattisgarh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Orissa, Punjab, Rajasthan, Sikkim, Tamil Nadu, Tripura, Uttar Pradesh, Uttaranchal and West Bengal), and 7 Union Territories (Andaman and Nicobar Islands, Chandigarh, Dadra and Nagar Haveli, Daman and Diu, Delhi, Lakshadweep and Pondicherry). The distributions shows a proportionality of human settlement with groundwater availability. The human consumption is usually segmented by agriculture, industry & domestic use and vary by regions depending upon overall topography and economic development. According to a Government of India Data for 1997-98, total water consumption in India was 629 BCM, 83.3% (524 BCM) in Irrigation and underground water represented about 46% in Irrigation Use. Domestic & Industry represented approx. 4.8% each and rest is in Power Generation (1.4%) and evaporation losses.

India accounts for 2.45% of land area and 4% of water resources of the world but represents 16% of the world population. With the present population growth-rate (1.9 per cent per year), the population is expected to cross the 1.5 billion mark by 2050. The Planning Commission of Government of India estimates water demand to increase from 710 BCM in 2010 to almost 1180 BCM in 2050 (shown below) with domestic and industry water consumption expected to increase almost 2.5 times.

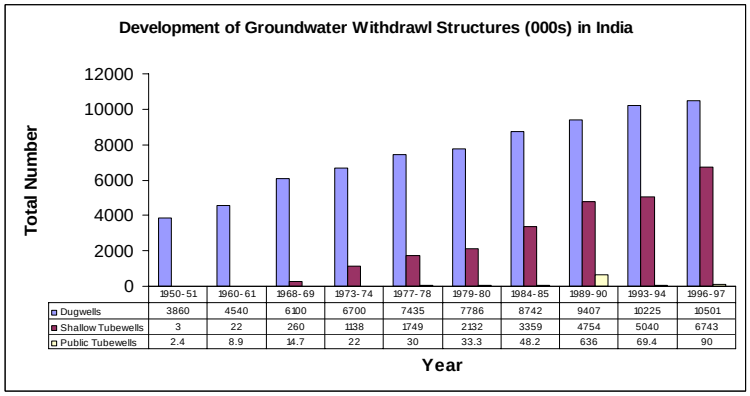
	2010		2025		2050	
WATER REQUIREMENTS	Low	High	Low	High	Low	High
Irrigation	543	557	561	611	628	807
Domestic	42	43	55	62	90	111
Industries	37	37	67	67	81	81
Power	18	19	31	33	70	70
Inland Navigation	7	7	10	10	15	15
Flood Control			Not available			
Afforestation			Not available			
Environment /Ecology	5	5	10	10	20	20
Evaporation Losses	42	42	50	50	76	76
Total (BCM)	**694**	**710**	**784**	**843**	**980**	**1180**

The chart below shows the demand distribution till 2050.



LOW ESTIMATE HIGH ESTIMATE

This growing demand indicates the increasing importance of groundwater resource. For irrigation, the water is pumped from under ground through 15 million (data on next page) motorized dug wells and tube wells. Shallow-zone within 50-meter depth is mostly a private effort and deeper zone (50 to 300 meter) is usually in the public sector for community irrigation. The overall development of groundwater withdrawal structures clearly indicates that its increasing importance for irrigation in last 50 years.



	1950-51	1960-61	1968-69	1973-74	1977-78	1979-80	1984-85	1989-90	1993-94	1996-97
Dugwells	3860	4540	6100	6700	7435	7786	8742	9407	10225	10501
Shallow Tubewells	3	22	260	1138	1749	2132	3359	4754	5040	6743
Public Tubewells	2.4	8.9	14.7	22	30	33.3	48.2	636	69.4	90

But these withdrawl structures are unevenly distributed across the country as topography for agriculture, weather conditions, size of human settlement and occupations in a particular region play a role in irrigation development.

	Abundant GroundWater	Less GroundWater
Low Irrigation Development	Lower Gangetic Plains, Eastern MP and North Eastern Region	Desert areas of Rajasthan, Himalayan Slopes
High Irrigation Development	Punjab, Haryana, Western UP	Peninsular India, Eastern Rajasthan, Gujarat

In addition to varying irrigation development, there are also concerns on water utilization in many of high irrigation development areas. According to an estimate by Food and Agriculture Organization (FAO), only 45% of water is effectively used in crop yield and the rest is lost in transmission to farm (15%), field application losses (25%) and farm distribution losses (15%).

On domestic front, groundwater is the most important backbone (80%) of water supply in India's rural population of 740 Million out of total of 1 billion as well as major urban cities. The needs of Urban Household vary, usually greater than the rural needs and so urbanization is pushing the demand. Similarly, the industry demand for water is also increasing with opening up of new enterprises driven by decade-old economic reforms. The water supply for these consumption points is managed by state-owned enterprise.

Government Organizations Managing Water

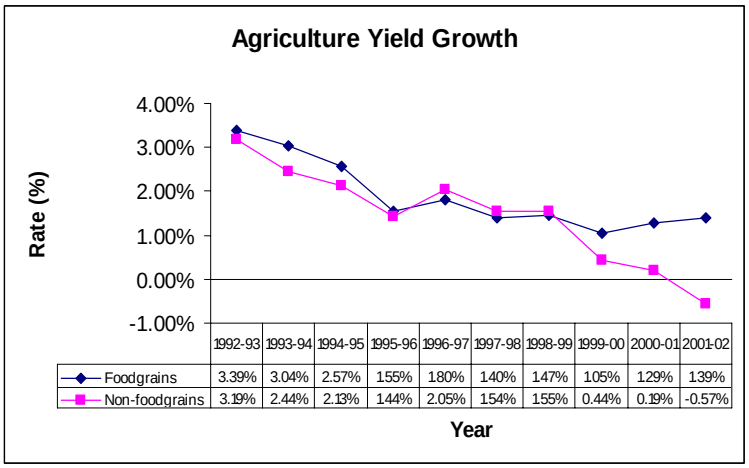
Ministry of Rural Development – Domestic Use of Water for Rural	Ministry of Power – Hydroelectric Generation
Ministry of Urban Development – Domestic Use of Water for Urban	Ministry of Non-conventional Energy Sources – Micro & Mini Hydel Projects
Ministry of Water Resources – Irrigation-related drought proofing & desert development	Ministry of Environment – Watershed Program

Although, the total financial allocation for all these very well intentioned efforts runs into billions of rupee, the emerging trends around irrigation, domestic supply and health, points out problems and it becomes clear that the benefits of groundwater development have somehow not been wisely re-invested in improving management of this key resource in a way which is important to address this growing demand.

EMERGING TRENDS RELEVANT TO GROUND FRESH WATER DEVELOPMENT

Groundwater Use in Irrigation: Impact on Agricultural Sector and Economy

Today, agricultural sector represents an important part of India's Economy. Nearly two-thirds of population depends upon agriculture but lately, this industry is becoming very risky. Agriculture Yield Growth (as shown below) has plummeted in last 10 years. The fact that yield growth is below population growth means that food grains production per capita is falling. Importantly, this is not a fluctuation caused by the weather; on the contrary, there has been a long string of good monsoons during the last decade, whereas there has been a steady downward trend in yield growth. The situation is even worse with non-food grains, which are cash crops such as edible oilseeds, cotton, jute, and sugarcane. Yield growth has turned *negative* for them, and production is propped up by turning over more and more area to these crops (the index of area under non-food grains grew 1.2 per cent per year during the 1990s). To further understand this trend, lets look at the current irrigation setup.



	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02
Foodgrains	3.39%	3.04%	2.57%	1.55%	1.80%	1.40%	1.47%	1.05%	1.29%	1.39%
Non-foodgrains	3.19%	2.44%	2.13%	1.44%	2.05%	1.54%	1.55%	0.44%	0.19%	-0.57%

The high irrigation development, after the Green Revolution in '70s, has resulted in over drafting in many regions. As per India's Central Ground Water Board's 1998 Report, 310 Blocks/Mandals/Talukas/Watersheds out of a total of 5831, fall under 'overexploited' category (utilization > 100 % of replenishable ground water) and 160 Blocks/Mandals/Talukas/ Watersheds fall under 'dark' category (utilization >85% but <100%) in 13 States of the country, namely, Andhra Pradesh, Bihar, Delhi, Gujarat, Haryana, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu and Uttar Pradesh. The number of blocks where groundwater has been overexploited and dark blocks has increased from 428 in 1995 to 470 (1998-99) and this trend continues. Approximately 12% of all aquifers are severely overdrawn. So, as the groundwater levels fall, the cost of groundwater extraction is increasing as drilling becomes more expensive for the deeper extraction. According to a Government of India 1989 statistics, the cost per hectare of irrigation (at 1970-1971 prices) rose from about Rupees 3300 in the first plan (1951) to Rupees 5400 in the seventh plan (1986) period.

In most Indian states, the water charges by the Government are low for irrigation, almost free. The cost recovery rate per hectare of irrigated land is in the range of about 20-25 percent of Operation and Management cost. So even with the increasing budget, there is an under investment in the irrigation system including agriculture power distribution grid (water withdrawal is an energy intensive operation and constitute a third of the power consumption in the country), making the ground water supply to farmers very unreliable and forcing farmers to invest their own money to get irrigation setup. Many of the rich farmers have been able to do it but for poor ones, this requires rural credit system which in most cases is not available. On crop supply side, crop prices are falling in the open market due to agricultural subsidies from other governments, only compunding the problem, thus making it difficult for poor peasants to hold on to their land for agricultural purposes and the result is land consolidation. The statistics clearly show that the percentage of landless households among rural has risen from 35 per cent in 1987-88 to 41 per cent in 1999-2000, and the percentage of households with marginal holdings too has risen from 19 per cent to 22 per cent. The landless and marginal account for 63 per cent of rural households, up from 55 per cent in 1987-88.

The sad part of the story is that the fall in growth of agricultural employment and land consolidation has not been accompanied by a rise in employment opportunities in the non-agricultural sectors. On the contrary withdrawal of the state and reduction in state expenditure has made it difficult for the labor declared surplus in agriculture to find alternative employment. In 1987-88, about 60% of the regular non-agricultural employees in rural areas were employed by the government, often in employment-generating programmes, which created almost 80% of the increments in such regular jobs during the 1980s. In 1990s the central government revenue expenditure declined on rural development, in public infrastructure and in energy investments which affect the rural areas. In addition, financial liberalization measures have effectively reduced the availability of rural credit. All this has resulted in growing unemployment in rural areas, greater migration to cities and thousands of farm suicides in last many years. Exact numbers are still unaccounted.

UNEMPLOYMENT RATES; 1993-94 AND 1999-2000 (PER THOUSAND)				
	Rural Males	Rural Women	Urban Males	Urban Females
1993-1994	56	56	67	105
1999-2000	72	68	72	98
Source: National Sample Survey (2000)				

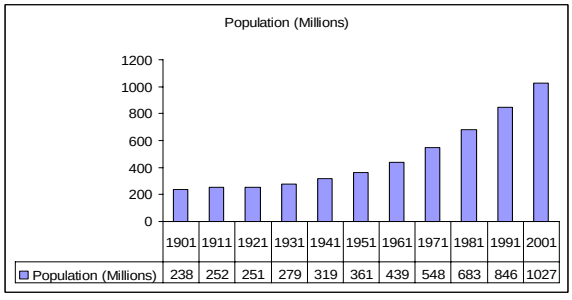
The Government has recently taken some corrective actions (announced "Grameen Rozgar Yojna") to address these issues but the outcome is yet to be seen. But it is definitely brewing a labor struggle. Apart from localized struggles of agricultural laborers breaking out to clinch a wage hike or secure job guarantees in the face of increased mechanization, the agricultural laborers' associations have started launching campaigns on a larger scale to popularize the class demands and strengthen the class identity of the rural proletariat. State-level strike actions have been organized so far in Bihar and West Bengal.

India's Agriculture industry is risky today. There is no doubt that an urgent look at irrigation price policy and rural credit system are needed to sustain it. Solutions cannot be just limited to those related to water distribution and efficient use. It should also encompass ideas around information systems that may provide real-time information and help in selection of competitive crops and creation of non-agro jobs.

Water Access for Domestic Use and Social Order

India has touched a population of One billion and growing at about 1.9% annually. Current domestic use include Fluid Intake, Bathing, Sanitation and Food Preparation and groundwater supplies is the most important backbone of drinking water supply in rural and urban India.

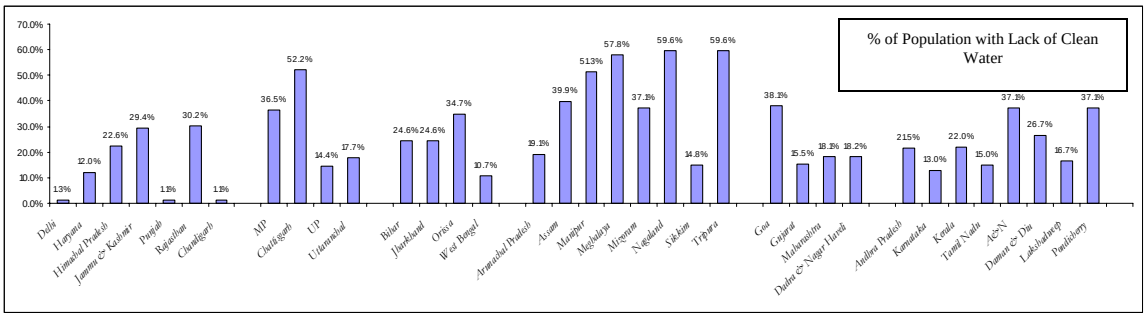
As of the latest census, more than 230 Million citizens do not have access to clean and fresh Drinking Water.



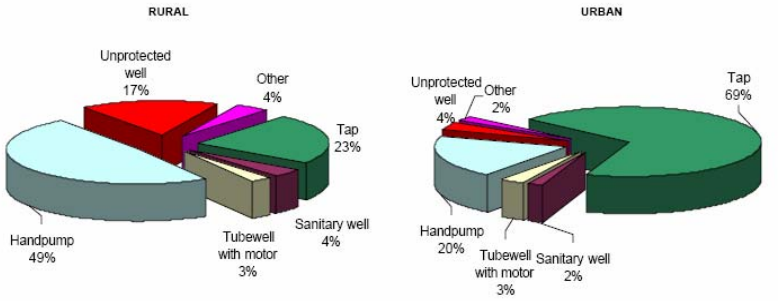
The chart below shows the % of population by states having lack of access to minimum clean water for domestic use (Fluid Intake, Bathing, Sanitation, and Food Preparation). It shows an unequal distribution of access to clean water by states and union territories. According to Water Experts, this lack of clean water can be attributed to many factors (but not limited to):

1. Geographic salinity in coastal areas and other contaminations such as Fluoride, Arsenic in Arid areas.
2. Waste disposal from urban areas and industry sectors.
3. Water Supply Management.

This mean that lack of access to clean drinking water is a very local problem and cannot have one single nationwide solution. For example, we can see the problem in coastal regions such as Kerala which is highest in the literacy rate in India, is of salinity (the ocean water mixing with underground aquifers due to extensive development) where as in Rajasthan the problems of arid-region applies and of course different solution set.



Out of these 230 million citizens who are without clean fresh water for deomestic use, 10% is urban population (28 million out of total of 280 million) and 27% is rural population (202 million out of total 740 million). Here is how water is accessed in rural vs urban households



Many of these water access points are not properly maintained or cleaned and making them vulnerable for water losses, disease points. In addition to lack of access to clean drinking water, domestic water supply is now being privatized – commoditizing a natural resource owned by all going in hands of few. Very recently, five companies have entered in India which are basically construction companies who will now be selling water - Suez Lyonnaise des Eaux (French), Bechtel Enterprises (American), Vivendi Environment (a French company now called Veslia), RWE/Thames Water (German) and Saur (French). These companies intend to channelize more and more water in the Indian mega cities and encash the growing need, but many rural communities have now been displaced from their original settlement as new water reservoirs are being assigned for cities. Women in poor households near these water points (for e.g. Tehri Dam in Uttaranchal) are suffering from severe stress as they now have to travel many miles every day to fetch water when all their life, they have been used to staying close to water. In addition, water imports is also starting to see increased activity.

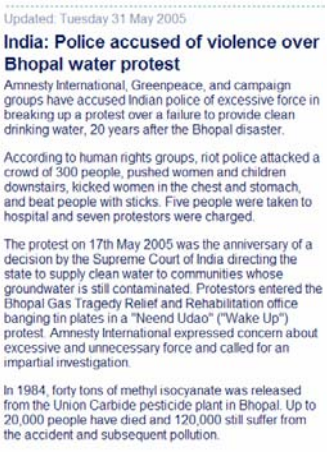
Water Sector Imports (US $M)

	1998-99	1999-00	2000-01	2001-02	2002-03	2002 Export Countries	% Share
Drinking water							
Water, including mineral water	$ 0.12	$ 0.49	$ 0.75	$ 0.38	$ 0.53	Bhutan	60%
						France	36%
						Germany	4%
Water Treatment							
Water treatment plant	$ 0.30	$ 0.06	$ 0.72	$ 0.33	$ 0.16	Australia	50%
						USA	19%
						Japan	31%
Waste Water treatment plant	N/A	$ 0.26	$0.33	$ 0.03	$0.96	USA	99%
						Switzerland	1%

The current import duty on water treatment plants of all kinds is 50.8%. The import duty on drinking water is 56.8% for branded and 35.2% for unbranded products.

Many experts agree that access to clean water is a basic human right and this level of contaminated access and privatization of domestic water supply is broiling conflicts in many corners of the society (see Press on Left)

If the correct domestic water policy is not put in place, water conflicts are inevitable and can lead to social and political upheaval in various regions of India in near future.



Updated: Tuesday 31 May 2005

India: Police accused of violence over Bhopal water protest

Amnesty International, Greenpeace, and campaign groups have accused Indian police of excessive force in breaking up a protest over a failure to provide clean drinking water, 20 years after the Bhopal disaster.

According to human rights groups, riot police attacked a crowd of 300 people, pushed women and children downstairs, kicked women in the chest and stomach, and beat people with sticks. Five people were taken to hospital and seven protestors were charged.

The protest on 17th May 2005 was the anniversary of a decision by the Supreme Court of India directing the state to supply clean water to communities whose groundwater is still contaminated. Protestors entered the Bhopal Gas Tragedy Relief and Rehabilitation office banging tin plates in a "Neend Udao" ("Wake Up") protest. Amnesty International expressed concern about excessive and unnecessary force and called for an impartial investigation.

In 1984, forty tons of methyl isocyanate was released from the Union Carbide pesticide plant in Bhopal. Up to 20,000 people have died and 120,000 still suffer from the accident and subsequent pollution.

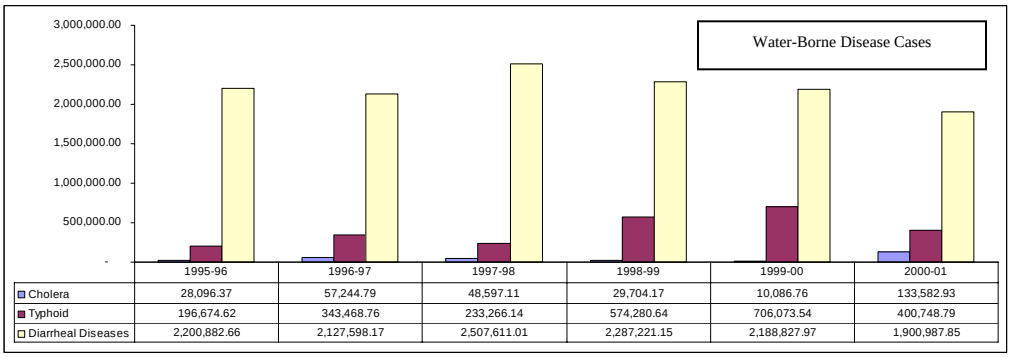
Rising Struggles, Falling Water

Anti-Coca-Cola Agitation Picks up in Kaladera, Rajasthan

Falling Water Tables, Sinking Hearts

Health and Biodiversity

With underground water contaminations, comes disease to entire biological system. The indiscriminate exploitation of groundwater has clearly changed the hydro-geo-chemical environment of the aquifers and enhanced the toxic and chemical levels of water beyond the permissible limit, mainly fluoride, arsenic, nitrate etc. The direct health impact of these toxic chemicals in drinking water is the manifestation of various water-borne and water-related diseases such as Cholera, Typhoid and Diarrheal diseases (Gastroenteritis, dysentery, diarrhea, jaundice). The chart below shows the six-year trend of number of accounted cases for these diseases.



	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01
Cholera	28,096.37	57,244.79	48,597.11	29,704.17	10,086.76	133,582.93
Typhoid	196,674.62	343,468.76	233,266.14	574,280.64	706,073.54	400,748.79
Diarrheal Diseases	2,200,882.66	2,127,598.17	2,507,611.01	2,287,221.15	2,188,827.97	1,900,987.85

Cholera is an infection of the small intestine caused by the bacterium. In 1950, there were 1,76,307 reported cases of cholera in India, with 86,997 deaths. A study done in 1995 showed only 28,000 cases of cholera in India and only 224 deaths (1%) due to cholera in that year. These numbers show a steady decline in the cases of cholera over the last fifty years for India in general.

Typhoid fever is a bacterial infection caused by the bacteria *Salmonella typhi*. The feces or urine of people infected with the disease can generally transmits the organism – thus clean sanitation is an important prevention mechanism. The death rate is approximately 16% for untreated cases and 1% for those given appropriate antibiotic therapy that totaled approx. 34,000 deaths in 1995.

Diarrheal disease, the primary cause of early childhood mortality, is linked to inadequate sewage disposal and lack of safe drinking water. According to a World Bank estimate, out of 1 million diarrhea deaths in India every year, more than 700,000 are children under 5, mostly in rural and urban slums. Another statistics confirms that people living in rural areas are somewhat more likely to have suffered from jaundice (1,410 per 100,000) than those living in urban areas (1,225 per 100,000). The prevalence of jaundice was highest for the age group 0–14 (1,515 per 100,000), followed by the age groups 15–59 (1,339 per 100,000) and 60 years and above (826 per 100,000).

These diseases have been persistent even when many Non-profit development organizations have come in to serve, private enterprises are selling more water filters and Government's health budget has increased over the years to cope with health need of growing population. It may also mean that there is some sort of permanent damage to underground aquifers due to pollution but further investigations would be needed to verify. In addition to human health, there have been some startling changes to the environment that have been observed as the human society continues wider consumption of groundwater ecosystem:

1. Organic loading of the subterranean environment (such as toxic chemicals like pesticides, various salts (potassium chloride, potassium nitrate) and heavy metals) lead, to extinctions of animals. It modifies the surface vegetation, especially leading to the disappearance of many plants. India has a total of 89,451 animal species accounting for 7.31% of the faunal species in the world and the flora accounts for 10.78% of the global total. According to the Red List of Threatened Animals, 44 plant species are critically endangered, 113 endangered and 87 vulnerable. Amongst animals, 18 are critically endangered, 54 endangered and 143 are vulnerable. Ten species are Lower Risk conservation dependent, while 99 are Lower Risk near threatened.

2. Water erosion in many semi-arid and arid regions has lead to decrease of soil fertility and land subsidence.

3. Shallow aquifers loaded with high concentrations of organic matter from anthropogenic activities (i.e. in areas of organic waste disposal) release nitrous oxides by denitrification. The concentration of this gas in contaminated aquifers is up to three orders of magnitude higher than that expected in equilibrium with the atmosphere and is responsible for acid rains and ecosystem damage.

It's very clear that children in rural and urban slums in India are today very prone to groundwater contaminations and the deadly diseases are surrounding them on an epidemic scale year after year. The biodiversity is also under tremendous pressure due to the current state of underground aquifers. Animal and plant extinction is bound to affect the entire food chain in the nature. Groundwater Management is increasingly becoming important to keep the balance of the entire ecosystem.

PHASE I CONCLUSION

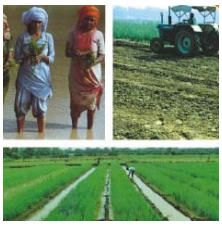
As we studied the current state of underground fresh water development and emerging trends, its very clear that given the growing demand of water for domestic and industry use, better management of underground aquifers and citizen participation is becoming important in correcting the water-related problems. Water is a life force that demands respect otherwise unabated human desires will lead to catasphrope of unimaginable size, as nature has its own limitations.

Its clear to build and implement an integrated plan, combining policy and grass-root action, to secure fresh water in order to sustain economic, social and environmental progress - key for future peace and prosperity of India. May God provide vision, wisdom and energy to move humans in the right direction.

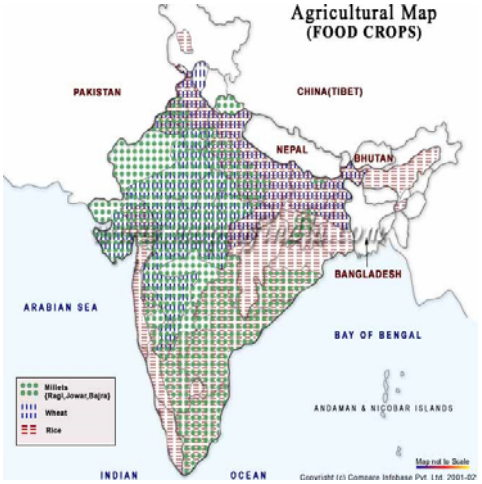
PHASE II

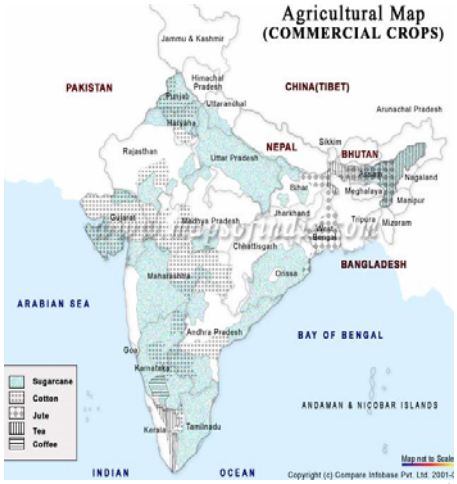
The intent of the second phase of study was to further analyze one of the trends, in this case we chose Agriculture Sector of Economy, to further understand current crop choices and analyze them through water consumption needs and how net value creation can be affected with the inclusion of water costs.

AGRICULTURE SECTOR IN INDIA



Agriculture in India is the means of livelihood of almost two thirds of the work force in the country. According to Ministry of Agriculture, Government of India, Uttar Pradesh, Maharasthra, Rajasthan, Madhya Pradesh and Karnataka are top 5 in terms of % of agriculture area and Uttar Pradesh, Punjab, Andhra Pradesh, West Bengal and Haryana are top 5 in terms of % of production. Below are two agricultural maps for food and commercial crops.



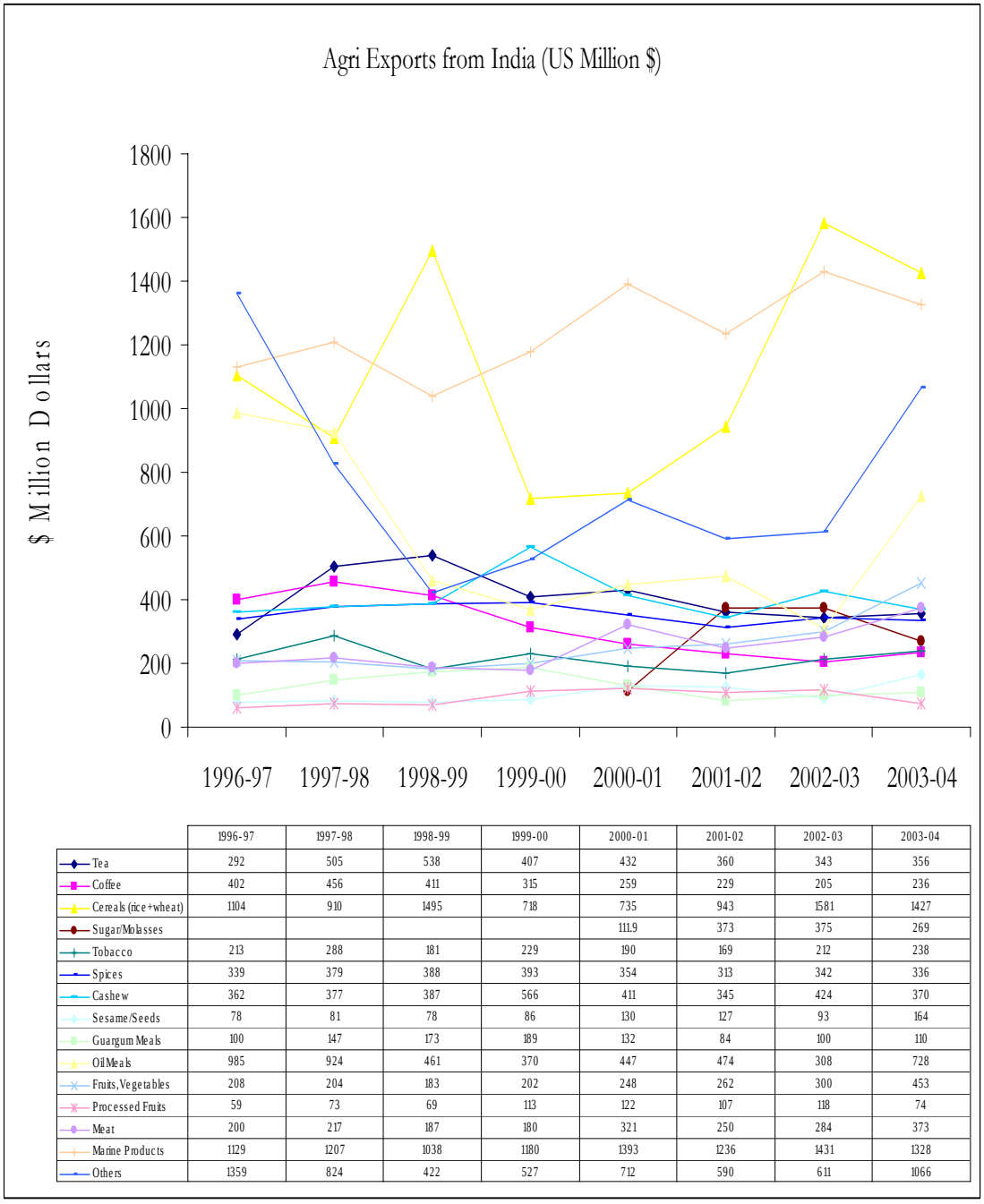


Map Source: Mapindia.com

The area, production and yield of India's major foodgrains producing states (2000-01 index)

STATES	AREA	PRODUCTION	YIELD	% of AREA	% OF TOTAL PRODUCTION
Uttar Pradesh	20.1	42.32	2105.5	16.78%	21.60%
Punjab	6.28	25.32	4031.8	5.24%	12.92%
Anadhra Pradesh	7.29	14.53	1993.1	6.09%	7.42%
West Bengal	6.24	13.83	2216.3	5.21%	7.06%
Haryana	4.29	13.25	3088.6	3.58%	6.76%
Bihar	7.25	12.06	1663.4	6.05%	6.16%
Karnataka	7.79	10.95	1405.6	6.50%	5.59%
Maharashtra	13.32	10.08	756.8	11.12%	5.14%
Rajasthan	11.36	10.04	883.8	9.48%	5.12%
Madhya Pradesh	9.85	8.93	906.6	8.22%	4.56%
Tamil Nadu	3.94	8.9	2258.9	3.29%	4.54%
Orissa	5.24	4.98	950.4	4.37%	2.54%
Assam	2.89	4.17	1442.9	2.41%	2.13%
Gujarat	3.15	3.68	1168.3	2.63%	1.88%
Chhatisgarh	4.57	3.65	798.7	3.82%	1.86%
Jharkhand	1.84	2.01	1092.4	1.54%	1.03%
Uttarnchal	1.01	1.73	1712.9	0.84%	0.88%
Others	3.37	5.49	1629.1	2.81%	2.80%
All India	119.78	195.92	1635.7		

In pro-reform era (1991) the share of agriculture in total GDP has shrinked. Therefore, there is a need to absorb excess agricultural labour in other sectors, notably industry. Agro - processing industry have started to emerge closed to the agricultural production centers to bring about this shift without moving people from rural to urban areas. The agri exports from India have also risen as the chart below shows, Cereals (Rice, Wheat) represent the largest export earner with $1.42 Billion in year 2003-04, followed by Marine products earning about $1.32 Billion and oil related products bringing almost $700 million. Fruits, Tea, Cashewnuts and Meat earn more than $300 million in exports.



	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04
Tea	292	505	538	407	432	360	343	356
Coffee	402	456	411	315	259	229	205	236
Cereals (rice+wheat)	1104	910	1495	718	735	943	1581	1427
Sugar/Molasses					111.9	373	375	269
Tobacco	213	288	181	229	190	169	212	238
Spices	339	379	388	393	354	313	342	336
Cashew	362	377	387	566	411	345	424	370
Sesame/Seeds	78	81	78	86	130	127	93	164
Guargum Meals	100	147	173	189	132	84	100	110
Oil Meals	985	924	461	370	447	474	308	728
Fruits, Vegetables	208	204	183	202	248	262	300	453
Processed Fruits	59	73	69	113	122	107	118	74
Meat	200	217	187	180	321	250	284	373
Marine Products	1129	1207	1038	1180	1393	1236	1431	1328
Others	1359	824	422	527	712	590	611	1066

Various Data Source: Economic Survey, Government of India, Compiled by: Prashant Gupta

AREA PATTERN OF IRRIGATED CROPS

To further understand India's irrgated crops, we looked at FAO's oveerall irrigation pattern in India, crop area as % of total area equipped for irrigation by months segmented by East, North, South and West part of India.

	Irrigated area (1000 ha)	Crop area as percentage of the total area equipped for irrigation by month											
		J	F	M	A	M	J	J	A	S	O	N	D
INDIA, EAST (Arunachal Pradesh, Assam, Bihar, Orissa, West Bengal, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura)													
Wheat	3671	41	41	41								41	41
Rice	6129												
Rice-one							34	34	34	34	34		
Rice-two		34	34	34								34	34
Maize	138						2	2	2	2	2		
Millet	121						1	1	1	1	1		
Sorghum	102						1	1	1	1	1		
Potatoes	83						1	1	1	1	1		
Pulses	248	3	3	3								3	3
Vegetables	222	2	2	2								2	2
Fruits	250	3	3	3	3	3	3	3	3	3	3	3	3
Rapeseed	56	1	1	1								1	1
Soybean	161						2	2	2	2	2		
Groundnut	72						1	1	1	1	1		
All irrigated crops	11251	83	83	83	3	3	44	44	44	44	44	83	83
Equipped for irrigation	9018												
Cropping intensity	125												

	Irrigated area (1000 ha)	Crop area as percentage of the total area equipped for irrigation by month											
		J	F	M	A	M	J	J	A	S	O	N	D
INDIA, NORTH (Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Uttar Pradesh, Chandigarh, Delhi)													
Wheat	6526	41	41	41								41	41
Rice	6786												
Rice-one							21	21	21	21	21		
Rice-two		21	21	21								21	21
Maize	413						3	3	3	3	3		
Barley	125						1	1	1	1	1		
Millet	363						2	2	2	2	2		
Sorghum	305						2	2	2	2	2		
Potatoes	147						1	1	1	1	1		
Sugarcane	1650	10	10	10	10	10	10	10	10	10	10	10	10
Pulses	1309	8	8	8								8	8
Vegetables	394	2	2	2								2	2
Fruits	444	3	3	3	3	3	3	3	3	3	3	3	3
Rapeseed	154	1	1	1								1	1
Soybean	286						2	2	2	2	2		
Cotton	1749				11	11	11	11	11	11	11		
All irrigated crops	20651	87	87	87	24	24	55	55	55	55	55	87	87
Equipped for irrigation	16032												
Cropping intensity	129												

	Irrigated area (1000 ha)	Crop area as percentage of the total area equipped for irrigation by month											
		J	F	M	A	M	J	J	A	S	O	N	D

INDIA, SOUTH (Andra Pradesh, Karnataka, Kerala, Tamil Nadu, Pondicherry)													
Wheat	204	2	2	2	2								2
Rice	7004												
Rice-one								35	35	35	35	35	
Rice-two		35	35	35	35								35
Maize	303							3	3	3	3	3	
Barley	92							1	1	1	1	1	
Millet	266	3	3	3	3								3
Sorghum	224	2	2	2	2								2
Potatoes	92							1	1	1	1	1	
Sugarcane	809	8	8	8	8	8	8	8	8	8	8	8	8
Pulses	141	1	1								1	1	1
Vegetables	246	2	2	2								2	2
Fruits	278	3	3	3	3	3	3	3	3	3	3	3	3
Soybean	179							2	2	2	2	2	
Groundnut	600							6	6	6	6	6	
Cotton	466	5						5	5	5	5	5	5
All irrigated crops	10905	61	57	55	53	11	11	63	63	63	64	67	61
Equipped for irrigation	10020												
Cropping intensity	109												

	Irrigated area (1000 ha)	Crop area as percentage of the total area equipped for irrigation by month											
		J	F	M	A	M	J	J	A	S	O	N	D
INDIA, WEST (Gujarat, Madhya Pradesh, Maharastra, Rajastan, Goa, Daman & Diu, D & N Haveli)													
Wheat	9994	66	66	66	66	66	66						66
Rice	1970							13	13	13	13	13	
Maize	523							3	3	3	3	3	
Barley	158							1	1	1	1	1	
Millet	459							3	3	3	3	3	
Sorghum	387							3	3	3	3	3	
Potatoes	138							1	1	1	1	1	
Sugarcane	777	5	5	5	5	5	5	5	5	5	5	5	5
Pulses	1839	12	12								12	12	12
Vegetables	369	2	2	2								2	2
Fruits	417	3	3	3	3	3	3	3	3	3	3	3	3
Rapeseed	302	2	2								2	2	2
Soybean	268							2	2	2	2	2	
Groundnut	224							1	1	1	1	1	
Cotton	1671					11	11	11	11	11	11	11	
All irrigated crops	19496	91	91	77	74	86	86	47	47	47	61	63	91
Equipped for irrigation	15030												
Cropping intensity	130												

Source: FAO

As groundwater is an important part of irrigation techniques, this provides an understanding of water need for irrigated crops.

WATER NEED OF CROPS

Although water is essential for crop growth, it's requirement for each crop is definite. It may change according to the season (Kharif, Rabi or Summer) or according to soil type (light, medium and heavy) but net requirement may not change. The total water requirements, critical stages of water application and number of irrigation turns through which this water is to be given are decided by experimentation.

To analyze Water Consumption, 33 crops were picked based upon agricultural export potential and domestic consumption. The area, production and yield data is based upon 2000-01 index.

Crop	Water Consumption (Litres per Kg)
Rice	1900
Wheat	1400
Jowar	400
Bajra	300
Cotton	5300
Maize	900
Groundnut	3500
Soyabean	2000
Gram	1670
Rapeseed & Mustard	2500
Sugarcane	2000
Tur (Arhar)	1800
Cocunut	1000
Sesame	600
Mango	400
Lentil (Masur)	1700
Potato	250
Spices	2000
Sunflower	600
Jute & Mesta	1300
Cashewnut	3000
LinSeed	2500
Tea	7000
Eggplants	200
Banana	400
Onion	350
Natural Rubber	1500
Coffee	10000
Tobacco	400
Apple	700
Oranges	500
Pineapple	500
Grapes	360

Coffee, Tea and Cotton are among top water consuming crops, followed by Groundnut, Rapeseed, Linseed, Sesame and sugarcane. This water need will further help determine the contribution cost of water in the value chain.

WATER COST

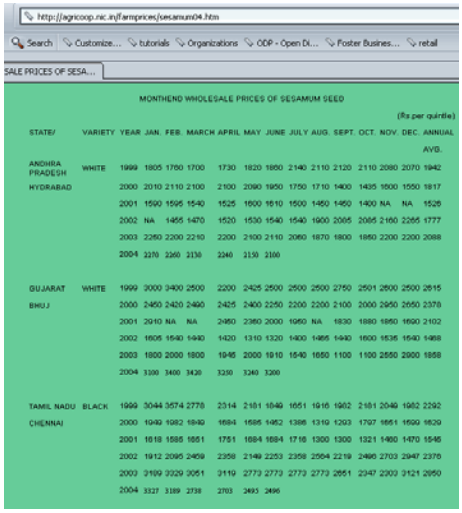
The National Water Policy of 1987, states that the water rate should be such that user knows the scarcity value of water and is motivated for efficient use of water. It was therefore expected that the water rate charged should cover annual maintenance and operation cost and a part of the fixed cost. However, the water rates have not been revised by most of the states for the last two or three decades. A few states revised water rates during the period 1981-86 but these new rates were not enforced.

According to FAO, average cost of Water Operation & Maintenance in India varying based on various states, technology use for e.g. Gujarat = Rs 2 per 1000 litres, Haryana = Rs. 0.04 per 1000 litres. So, assumed average cost of water is estimated as **Rs 0.25 per 1000 liters** for analysis and calculations.

PRODUCER PRICES

The main objectives of the Government's price policy for agricultural produce aims at ensuring remunerative prices to the growers for their produce. with a view to encouraging higher investment and production. Towards this end, minimum support prices (MSP) for major agricultural products are announced each year which are fixed after taking into account the recommendations of the Commission for Agricultural Costs and Prices (CACP). Of all the factors, cost of production is the most tangible factor and it takes into account all operational and fixed demands.

Government organizes Price Support Scheme (PSS) of the commodities, through various public and cooperative agencies, for which the MSPs are fixed. Farm producer prices in each of the state is provided by Department of Agriculture. So, we calculated average of all the producer prices and use that to generate the total revenues per hectare.


http://agricoop.nic.in/farmprices/sesamum04.htm

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SALE PRICES OF SESA...

MONTHEND WHOLESALE PRICES OF SESAMUM SEED

(Rs per quintle)

STATE/	VARIETY	YEAR	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL AVG.
ANDHRA PRADESH	WHITE	1999	1805	1760	1700	1730	1820	1850	2140	2110	2120	2110	2080	2070	1942
HYDRABAD		2000	2010	2110	2100	2100	2090	1950	1750	1710	1400	1435	1500	1550	1817
		2001	1590	1595	1540	1525	1600	1610	1500	1450	1450	1400	NA	NA	1526
		2002	NA	1455	1470	1520	1530	1540	1540	1900	2065	2065	2160	2265	1777
		2003	2250	2200	2210	2200	2100	2110	2060	1870	1800	1850	2200	2200	2088
		2004	2270	2260	2130	2240	2150	2100							
GUJARAT	WHITE	1999	3000	3400	2500	2200	2425	2500	2500	2500	2750	2501	2500	2500	2615
BHUJ		2000	2450	2420	2400	2425	2400	2250	2200	2200	2100	2000	2950	2650	2378
		2001	2910	NA	NA	2450	2360	2000	1950	NA	1830	1880	1850	1690	2102
		2002	1605	1540	1440	1420	1310	1320	1400	1465	1440	1600	1535	1540	1458
		2003	1800	2000	1800	1945	2000	1910	1540	1650	1100	1100	2550	2900	1858
		2004	3300	3400	3420	3250	3240	3200							
TAMIL NADU	BLACK	1999	3044	3574	2778	2314	2181	1640	1651	1916	1902	2181	2049	1982	2292
CHENNAI		2000	1949	1982	1849	1684	1695	1462	1386	1319	1293	1797	1651	1690	1629
		2001	1818	1585	1851	1751	1884	1884	1718	1300	1300	1321	1460	1470	1545
		2002	1912	2095	2459	2358	2149	2253	2358	2504	2219	2466	2703	2947	2376
		2003	2199	3329	3051	3119	2773	2773	2773	2773	2651	2347	2303	3121	2950
		2004	3327	3189	2738	2703	2493	2496							

The Ministry of Agriculure publishes the farm producer prices in different areas and based on that we have calculated the producer prices.

Example:

SESAME CALCULATION:

- Rate in Andhra Pradesh = Rs. 1817
- Rate in Gujarat = Rs. 2378
- Rate in Tamil Nadu = Rs. 1629

Average whole sale price of seasame seed for year 2000 = (1817+2378+1629)/3 = Rs 1941.33 per 100 kg.

SPICE CALCULATION: In terms of prinipal spices, averages are: Ginger (Rs. 4000 per quintal), Turmeric (Rs. 3000 per quintal), Black pepper (Rs. 20,000 per quintal), Chilles (Rs. 4000 per quintal)

RICE CALCULATION: Four type of rice – Common (Rs 913.5 per quintal), Fine (Rs. 1085.5 per quintal), Basmati (Rs. 2456.75 per quintal) and Paddy (Rs. 598 per quintal) price were included.

WHEAT CALCULATION: Two type of Wheat – Mexican (Rs 618 per quintal), Traditional (Rs. 833.5 per quintal) price were included.

As the chart below shows, Cashewnut, spices, oranges and tea derive the highest producer prices, followed by Mango, linseed, coconut, coffee and rubber.

Crop	Producer Prices (Rs per 100 kg)
Rice	INR 1,263.44
Wheat	INR 725.75
Jowar	INR 520.50
Bajra	INR 459.25
Cotton	INR 918.33
Maize	INR 423.50
Groundnut	INR 1,480.33
Soyabean	INR 861.00
Gram	INR 1,656.50
Rapeseed & Mustard	INR 1,183.60
Sugarcane	INR 56.10
Tur (Arhar)	INR 1,493.00
Cocunut	INR 2,432.25
Sesame	INR 1,941.33
Mango	INR 3,000.00
Lentil (Masur)	INR 1,690.25
Potato	INR 324.50
Spices	INR 7,750.00
Sunflower	INR 1,022.67
Jute & Mesta	INR 1,036.33
Cashewnut	INR 22,334.33
LinSeed	INR 2,033.33
Tea	INR 8,000.00
Eggplants*	INR 500.00
Banana	INR 500.00
Onion	INR 403.33
Natural Rubber	INR 4,000.00
Coffee	INR 3,000.00
Tobacco	INR 2,467.25
Apple	INR 1,000.00
Oranges	INR 8,000.00
Pineapple	INR 1,000.00
Grapes	INR 2,000.00

ANALYSIS

The intent of analysis is to understand water requirement to generate revenues and impact of water costs on the % gross margin considering cost as fixed variable. Given, water needs for each crop, water costs per hectare and producer prices, we can sort each crop by revenue per hectare, water cost per hectare etc. (Detailed analyzed data attached as Appendix)

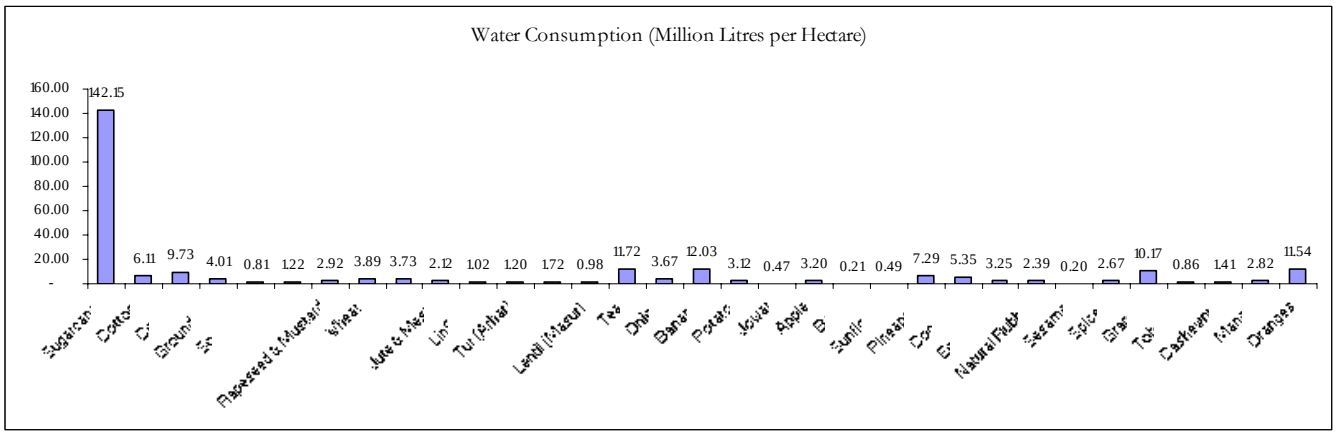
Model:

- Area (A) = The land used for crop production (measured in million hectares)
- Production (P)= The weigth of total crop production (measured in Kilograms or kg)
- Yield (Y) = Production / Area (measured in Kg per hectare)
- Water Need for Crop Production (WNCP) = measured in Litres per Kg
- Producer Price of Crop (PPC) = measured in Rupees per 100 Kg
- Fixed Water Cost (FWC) = Rs. 0.25 per 1000 liters

The available data for 33 crops have been assimiliated together:

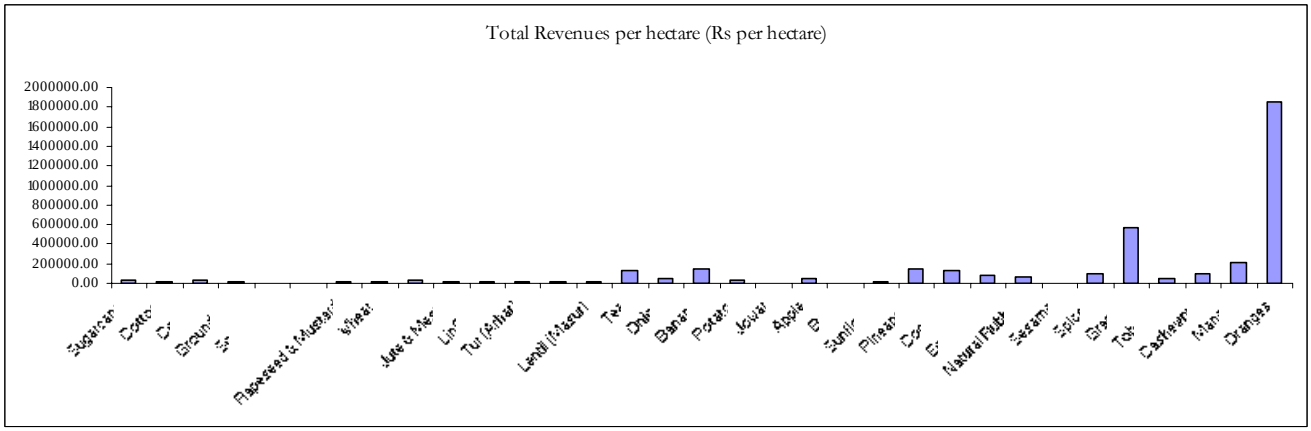
Crop	**Area – A** (Million hectares)	**Production - P** (Million kg)	**Yield - Y** (kg per hectare)	**Water Need for Crop Production - WNCP** (Litres per Kg)	**Producer Price of Crop - PPC** (Rs per 100 kg)
Sugarcane	4.21	299230	71076.0	2000	56.10
Cotton	8.53	9840	1153.6	5300	918.33
Coffee	0.30	292	973.3	10000	3000.00
Groundnut	6.56	7510	1144.8	3500	1480.33
Soyabean	6.42	2600	405.0	2000	861.00
Maize	6.61	8960	1355.5	900	423.50
Rapeseed & Mustard	4.48	5230	1167.4	2500	1183.60
Wheat	27.48	76369	2779.1	1400	725.75
Rice	44.71	87697	1961.5	1900	1263.44
Jute & Mesta	1.02	1661	1628.8	1300	1036.33
LinSeed	0.59	241	408.1	2500	2033.33
Tur (Arhar)	3.63	2410	663.9	1800	1493.00
Gram	5.19	5360	1032.8	1670	1656.50
Lentil (Masur)	1.48	850	574.3	1700	1690.25
Tea	0.50	837	1673.6	7000	8000.00
Onion	0.45	4721	10491.1	350	403.33
Banana	0.47	14140	30085.1	400	500.00
Potato	1.22	15210	12467.2	250	324.50
Jowar	9.86	11680	1184.6	400	520.50
Apple	0.23	1050	4565.2	700	1000.00
Bajra	9.83	6890	700.9	300	459.25
Sunflower	1.07	870	813.1	600	1022.67
Pineapple	0.07	1020	14571.4	500	1000.00
Cocunut	1.82	9730	5346.2	1000	2432.25
Eggplants*	0.50	8120	16240.0	200	500.00
Natural Rubber	0.39	622	1595.5	1500	4000.00
Sesame	1.72	587	341.3	600	1941.33
Spices	1.20	1600	1333.3	2000	7750.00
Grapes	0.04	1130	28250.0	360	2000.00
Tobacco	0.26	560	2153.8	400	2467.25
Cashewnut	0.63	295	470.5	3000	22334.33
Mango	1.49	10500	7047.0	400	3000.00
Oranges	0.13	3000	23076.9	500	8000.00

Water Need per Crop hectare (WNCH) = Y x WNCP , million litres per hectare

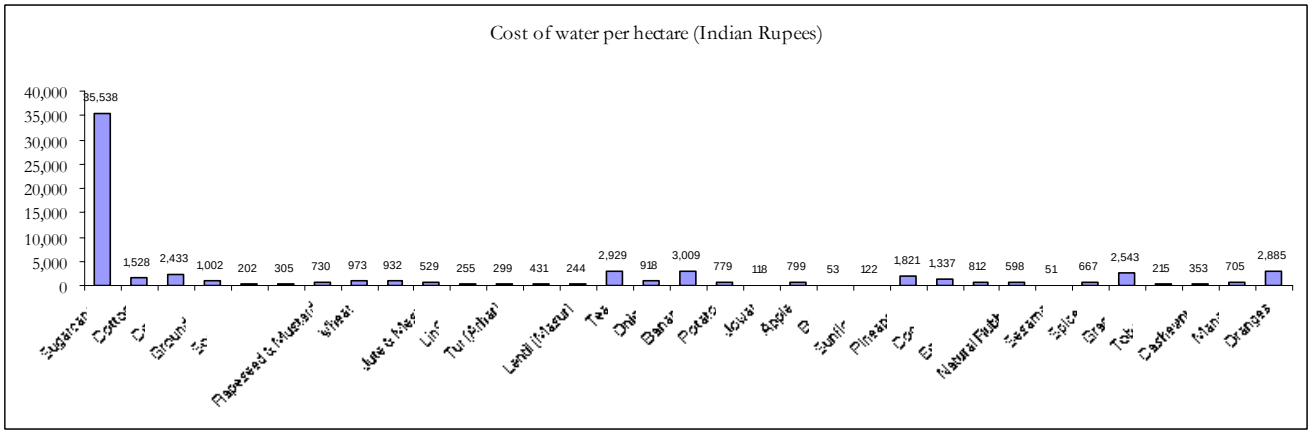


Revenue per Crop Hectare (RCH) = PPC x Y, Rupees per hectare

This is based strictly on producer prices and do not include revenues from bi-products such as Sugar products from Sugarcane.



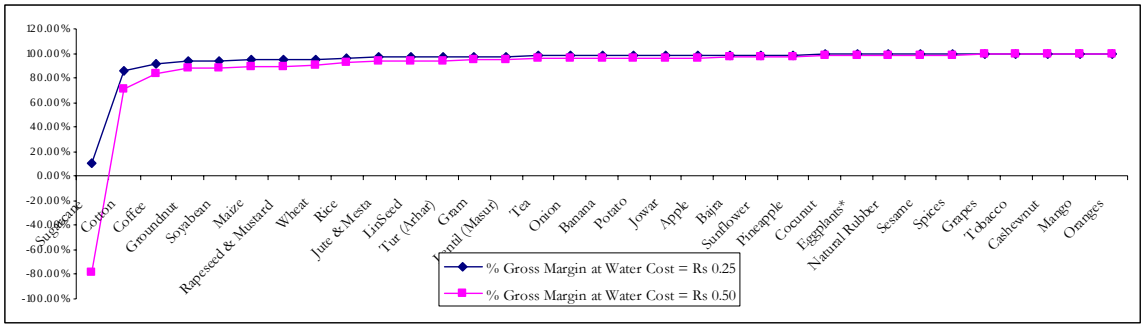
Total liters of water needed for Rs. 1 of Revenue Generation = WNCH / RCH



Water Cost per Crop Hectare (WCCH) = WNCH x FWC, Rupees per hectare

Crop	Cost of water per hectare (*Rs 0.25 per 1000 litres*)
Rice	Rs. 932
Wheat	Rs. 973
Jowar	Rs. 118
Bajra	Rs. 53
Cotton	Rs. 1,528
Maize	Rs. 305
Groundnut	Rs. 1,002
Soyabean	Rs. 202
Gram	Rs. 431
Rapeseed & Mustard	Rs. 730
Sugarcane	Rs. 35,538
Tur (Arhar)	Rs. 299
Cocunut	Rs. 1,337
Sesame	Rs. 51
Mango	Rs. 705
Lentil (Masur)	Rs. 244
Potato	Rs. 779
Spices	Rs. 667
Sunflower	Rs. 122
Jute & Mesta	Rs. 529
Cashewnut	Rs. 353
LinSeed	Rs. 255
Tea	Rs. 2,929
Eggplants	Rs. 812
Banana	Rs. 3,009
Onion	Rs. 918
Natural Rubber	Rs. 598
Coffee	Rs. 2,433
Tobacco	Rs. 215
Apple	Rs. 799
Oranges	Rs. 2,885
Pineapple	Rs. 1,821
Grapes	Rs. 2,543

So, if the water costs increases to Rs. 0.50 per 1000 litres and included in the cost, the % of gross margin on the revenues will fall most dramatically for Sugarcane (as shown below):



CONCLUSION

1. Sugarcane requires highest water consumption to generate unit revenue. This is followed by cotton, coffee, groundnut and soyabean.
2. Fruits such as Oranges, Grapes, Mango, Banana, Pineapple produces very high revenue per hectare, a good potential for exports and have very small water need.
3. Sugarcane crop seems to be one of the primary reason of over drafting of under ground water in many parts of Gangetic Aquifier (such as Uttar Pradesh and Punjab) as famers continue to grow this crop year by year under pressure from exporters of its bi-products.
4. If the cost of water rises due to falling water levels and deeper underground drilling, sugarcane will continue to push down the overall agriculture economy, followed by cotton.
5. For future security of underground water resource of India, replacement crops should be considered for a portion of Sugarcane crop that consume less water and generate more revenues.

AGRICULTURE SECTOR POLICY RECOMMENDATION

Based on last six months of work on underground water development in India, learning about emerging trends pertaining to agricultural sector and pressures on overall health of ecosystem, it is very clear that water is one of the key factors to order, sustenance and security in India in coming years. With 1 billion population, this life-giving commodity needs to be respected and cared for. And this is especially relevant to Agriculture Sector that holds 2/3rd of workforce. The government should take another look at crops such as Sugarcane as it is only encouraging overdrafting of ground water. Here are our policy recommendations:

1. Introduce a special **water tax on Exporters of Sugarcane and Cotton bi-products** and channelize this tax money on water drilling and rainwater harvesting methods for these two crops.

2. Provide advance cash and markting channel for farmers to **grow fruits replacing sugarcane and invest in fruit-processing industry.** This will create new jobs, grow export revenue by consuming less water.

The main idea behind these two recommendations is reduce pressure of ground water aquifers while create new growth opportunity in the agriculture sector. As water is a life force that may perish or flourish a Nation, we believe that it is critical to understand & take action on this for regional peace and prosperity of Indian Subcontinent.

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- http://www.devalt.org/water/WaterinIndia/characteristics.htm#Demands
- http://www.ficci.com/ficci/media-room/speeches-presentations/2003/sep/sep5-asean-kirloskar.htm
- Ministry of Agriculture, Government of India
- Food and Agriculture Organization (FAO) Statistics System
- FAO Document – Water Charging in Irrigation Agriculture
- http://agmarknet.nic.in/rep1.asp

APPENDIX A – Ground Water Sources

Major River Basins

Sl. No.	Major River Basin	Origin	Catchment Area (Sq. Km.)	Surface Water - average annual potential in river (BCM)	Total Replenishable Ground Water Resources (BCM)
1	Indus	Mansarovar (Tibet)	321289 +	73.31	26.49
2	Ganga	Gangotri (Uttar Kashi)	861452 +	525.02	170.99
	Brahmaputra	Kailash Range (Tibet)	194413 +	585.6	26.55
	Barak and other rivers flowing into Meghna, like Gomti, Muhari, Fenny etc.		41723 +		8.52
3	Sabarmati	Aravalli Hills (Rajasthan)	21674	3.81	
4	Mahi	Dhar (Madhya Pradesh)	34842	11.02	
5	Narmada	Amarkantak (Madhya Pradesh)	98796	45.64	10.83
6	Tapi	Betul (Madhya Pradesh)	65145	14.88	8.27
7	Brahmani	Ranchi (Bihar)	39033	28.48	4.05
8	Mahanadi	Nazri Town (Madhya Pradesh)	141589	66.88	16.46
9	Godavari	Nasik (Maharashtra)	312812	110.54	40.65
10	Krishna	Mahabaleshwar (Maharashtra)	258948	78.12	26.41
11	Pennar	Kolar (Karnataka)	55213	6.32	4.93
12	Cauvery	Coorg (Karnataka)	81155	21.36	12.3
		Total	2528084	1570.98	356.45

Minor River Basins

	Total Replenishable Ground Water Resources (BCM)
Subarnarekha (Bihar)	1.82
Cambai Composite	7.19
Kutch and Saurashtra Composite	11.23
Madras and South Tamil Nadu	18.22
Northeast Composite	18.84
Western Ghat	17.69
Additional Ground Water	74.99

APPENDIX B – Case Study: State of Rajasthan

The total population of Rajasthan is 53.9 million (2001 Census). The breakup is as follows:

Region	2001 Population	% Pop.	% of Coverage*	With Surface Water	With Ground Water	With Surface/ Ground
Urban: 222 cities and towns	13.0 million	23.5%	N/A	40	151	31
Rural: 221 towns	11.5 million	22.2%	N/A			
Rural: 39787 Village	29.4 million	54.3%	94.5%	4408	33267	-
Rural: 82633 Habitations			64.5%		56057	-

According to Census 1991 – 85,049 (90%) villages and habitations were fully covered without taking water quality aspect. By 2001, the number of villages and habitations (population) have increased and as the water quality was included in analysis 53% of these regions are not at all covered. Also, rural water supply are mostly based on ground water, about 91%.

Urban Deployment

By Ministry of Urban Development

Individual Connections	76%
Hand Pumps	5%
Public Taps	3%

By Other Systems

Private Systems	6%
Private Wells	8%
Other means	2%

Rural Deployment (Villages)

Type of Scheme	Number of Villages	%
Piped	1811	5%
Pump and Tank	2993	8%
Regional Scheme	9826	26%
Hand Pump	21639	57%
TSS	1129	3%
Diggi	279	1%

State's Population Forecast

	2001	2005	2015	2045
Total	56.4 M	61 M	72.9 M	102.9 M
Urban	13.2 M	16.9 M	24.9 M	50 M
Rural	43.2 M	44.1 M	48 M	52. 9 M

Clearly, urban population (comfort living) is growing in the state. So, the demand for water (Mm3/yr) is increasing.

Mm3/yr	2005	2015	2045
Towns	739	1017.5	1921.6
Cities	853.8	988.6	1266.1
Rural	989.6	1169	1537.1
Total	2583.0	3175.1	4724.8

APPENDIX C

CROP Data Collection and Analysis

Crop	Area (Million hectares)	Production (Million kg)	Yield (kg per hectare)	Water Consumption (Litres per Kg)	Producer Prices (Rs per 100 kg)	Water Consumption (Million Litres per Hectares)	Total Revenues per hectare (Rs per hectare)	Water consumption per revenue generation	Cost of water per hectare (*Rs 0.25 per 1000 litres*)	% Gross Margin with water costs = Rs. 0.25	Cost of water per hectare (*Rs 0.50 per 1000 litres*)	% Gross Margin with water costs = Rs. 0.50
Sugarcane	4.21	299230	71076.0	2000	56.10	142.15	39873.64	3,565.06	35,538	10.87%	71,076	-78.25%
Cotton	8.53	9840	1153.6	5300	918.33	6.11	10593.67	577.13	1,528	85.57%	3,057	71.14%
Coffee	0.30	292	973.3	10000	3000.00	9.73	29200.00	333.33	2,433	91.67%	4,867	83.33%
Groundnut	6.56	7510	1144.8	3500	1480.33	4.01	16947.11	236.43	1,002	94.09%	2,003	88.18%
Soyabean	6.42	2600	405.0	2000	861.00	0.81	3486.92	232.29	202	94.19%	405	88.39%
Maize	6.61	8960	1355.5	900	423.50	1.22	5740.64	212.51	305	94.69%	610	89.37%
Rapeseed & Mustard	4.48	5230	1167.4	2500	1183.60	2.92	13817.47	211.22	730	94.72%	1,459	89.44%
Wheat	27.48	76369	2779.1	1400	725.75	3.89	20169.14	192.90	973	95.18%	1,945	90.35%
Rice	44.71	87697	1961.5	1900	1263.44	3.73	24781.91	150.38	932	96.24%	1,863	92.48%
Jute & Mesta	1.02	1661	1628.8	1300	1036.33	2.12	16880.04	125.44	529	96.86%	1,059	93.73%
LinSeed	0.59	241	408.1	2500	2033.33	1.02	8298.76	122.95	255	96.93%	510	93.85%
Tur (Arhar)	3.63	2410	663.9	1800	1493.00	1.20	9912.20	120.56	299	96.99%	598	93.97%
Gram	5.19	5360	1032.8	1670	1656.50	1.72	17107.59	100.81	431	97.48%	862	94.96%
Lentil (Masur)	1.48	850	574.3	1700	1690.25	0.98	9707.52	100.58	244	97.49%	488	94.97%
Tea	0.50	837	1673.6	7000	8000.00	11.72	133888.00	87.50	2,929	97.81%	5,858	95.63%
Onion	0.45	4721	10491.1	350	403.33	3.67	42314.15	86.78	918	97.83%	1,836	95.66%
Banana	0.47	14140	30085.1	400	500.00	12.03	150425.53	80.00	3,009	98.00%	6,017	96.00%
Potato	1.22	15210	12467.2	250	324.50	3.12	40456.11	77.04	779	98.07%	1,558	96.15%
Jowar	9.86	11680	1184.6	400	520.50	0.47	6165.76	76.85	118	98.08%	237	96.16%
Apple	0.23	1050	4565.2	700	1000.00	3.20	45652.17	70.00	799	98.25%	1,598	96.50%
Bajra	9.83	6890	700.9	300	459.25	0.21	3218.95	65.32	53	98.37%	105	96.73%
Sunflower	1.07	870	813.1	600	1022.67	0.49	8315.14	58.67	122	98.53%	244	97.07%
Pineapple	0.07	1020	14571.4	500	1000.00	7.29	145714.29	50.00	1,821	98.75%	3,643	97.50%
Cocunut	1.82	9730	5346.2	1000	2432.25	5.35	130031.83	41.11	1,337	98.97%	2,673	97.94%
Eggplants*	0.50	8120	16240.0	200	500.00	3.25	81200.00	40.00	812	99.00%	1,624	98.00%
Natural Rubber	0.39	622	1595.5	1500	4000.00	2.39	63821.54	37.50	598	99.06%	1,197	98.13%
Sesame	1.72	587	341.3	600	1941.33	0.20	6626.49	30.91	51	99.23%	102	98.45%
Spices	1.20	1600	1333.3	2000	7750.00	2.67	103333.33	25.81	667	99.35%	1,333	98.71%
Grapes	0.04	1130	28250.0	360	2000.00	10.17	565000.00	18.00	2,543	99.55%	5,085	99.10%
Tobacco	0.26	560	2153.8	400	2467.25	0.86	53140.77	16.21	215	99.59%	431	99.19%
Cashewnut	0.63	295	470.5	3000	22334.33	1.41	105081.79	13.43	353	99.66%	706	99.33%
Mango	1.49	10500	7047.0	400	3000.00	2.82	211409.40	13.33	705	99.67%	1,409	99.33%
Oranges	0.13	3000	23076.9	500	8000.00	11.54	1846153.85	6.25	2,885	99.84%	5,769	99.69%

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