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UNDERSTANDING THE NEXUS OF GROUNDWATER IRRIGATION AND FOOD SECURITY IN INDIA

Rajni Bala*

ABSTRACT

Over the past 25 years, massive changes have occurred in agriculture sector of the world economy, but insecurity regarding food sufficiency is still prevailing in most of the developing countries. India aims to be a self-enough country in food availability which makes it imperative to grow sufficient food within the country. To attain this goal, State and Central governments intervene in providing uninterrupted food supply to safeguard the farmers against unpredictable food prices. India's food security depends upon adequate agricultural production and agricultural production can be augmented only through proper irrigation facilities. Indian policy planners emphasize to expand and upgrade irrigation facilities. In irrigation sector, groundwater use became feasible resource in comparison with the canal irrigation in India. Initially this proved helpful in food production, but overuse of this resource has emerged as a drag over enhancing food production. This paper highlights the role of groundwater irrigation in attaining food security. The period covered is from Green revolution period onwards. The paper also elucidates the critical condition of groundwater resource and its possible impacts over food security.

Keywords: Agriculture, Groundwater boom, Groundwater Contours, Impacts on food security.

INTRODUCTION

A large part of Indian population is dependent on agriculture sector for its sustenance. Agriculture is also counted as the backbone of the Indian economy. Since independence, all the agricultural policies of the successive govrnments have aimed at reducing poverty, hunger and food insecurity. Undoubtedly, the decade of 1960s is marked as a watershed decade.

***Rajni Bala** is a Ph.D. Research Scholar(UGC-JRF) at the Department of Political Science, Panjab University, Chandigarh.

Several challenges in the field of agriculture were addressed. New innovative technologies were introduced to enhance the production in agriculture sector. The period now known as the Green Revolution period has another epithet, *Tubewell Revolution's* period. Groundwater irrigation played an important role in India's agriculture and food security. The applications of the recommended fertilizer and other type of agronomic practices demands excessive water for irrigation and that can be only fulfilled from groundwater that is easily accessible for those who have their economic resource. Gandhi (2009) found that groundwater irrigation has become the main source of growth in irrigated area over the past three decades and it now accounts for over 60 percent of the irrigated area in the country. His study also examined that over 70 percent of India's foodgrain production comes from irrigated agriculture in which groundwater have an important role.

But, during the last decade, the decreasing trends of productivity in wheat and paddy production and the stagnation in yield has baffled the policy makers. The threat of insecurity of the food sufficiency looms large. FAO defines the food security in following words: "Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996). Food security is a major and primary challenge for every government in ensuring good governance. This ultimately creates a lot of pressure upon natural resources for more production. Since over 70% of India's foodgrain is grown in the irrigated belt and groundwater plays a significant role in realizing this. In this situation, it can be discerned that natural resources like water and groundwater can only be ignored by mismanagement and indiscriminate exploitation at nation's peril. Such exploitative practices of the available water resources and groundwater resources can lead to catastrophic situation in agriculture sector. Thus, the sustainability of groundwater resource and food security is a major challenge. The paper will explore the nexus between these two salient dimensions of current scenario in Indian agriculture.

The main aim of this paper is to provide the thematic overview of the nexus between groundwater irrigation and food security. The paper has two parts; first part will present the historical overview of groundwater booming that proved helpful for food security. Second part of this paper will analyze current challenges for groundwater resources in view of the requirement of enhanced food production.

GROUNDWATER BOOM AND THE FOOD SECURITY IN INDIA

After independence, State has been the architect, entrepreneur, engineer and manager of irrigation systems in India and millions of small farmers gained from several initiatives undertaken by the governments in the field of irrigation. India followed the irrigation model of 1830's in which command areas were created near hydraulically opportune sites where reservoirs or weirs could be built and downstream areas could be 'commanded' by gravity flow (Tushaar Shah,2006). But, Indian agriculture suffered during the Second World War (1939-43) resulting in the Bengal famine of 1943 and major food scarcity. It was felt that state ought to make public intervention for reducing food scarcity.

Since independence, Indian agricultural policy faced an ongoing tension between pressure to reduce regional and local inequalities and pressure to increase agricultural growth. Policy planners put primary emphasis on inclusive growth during India's first three Five-Year Plans (1951-52 to 1965-66). Wide range of initiatives was promoted to spread the public investment in agriculture and rural development. Overall in this period, the main emphasis was on agrarian reorganization, land reform and to reform inefficiencies of a semi-feudal agrarian structure. By the mid 1960s, however, it had become clear that this development strategy had not worked. At the same time, India faced the problem of food insecurity and that caused political havoc. In addition, India's food security was dependent on continued wheat imports from the United States, known as PL 480 shipments. Under such pressure, India's lack of food self-sufficiency represented a clear threat to national sovereignty. International organizations, especially the World Bank, also applied pressure by making much-needed aid contingent on the adoption of agricultural policies aimed at increasing output (Witsoe, 2006).

Agricultural development through better input was the best option to achieve the food security goal. To achieve it, groundwater irrigation was also considered as a viable technical option to reduce water-logging and salinity in certain areas of river basins. Conscious and proactive government policy was promoted to get agricultural productivity and overall development at the cost of natural resources. It was assumed that food subsidy; especially the Minimum Supporting Price (MSP) can encourage the farmers to go for more food production. Energy and groundwater are key instruments for agricultural production. Irrespective of the changes in the energy policy, the demand for groundwater depends upon what farmers grow, which in turn is influenced by the support price policy, agriculture (food security) policy, and market linkages(Shah *et.al.*, 2004).

Digging of groundwater for agricultural productivity depended firmly on access to electricity and a provision of subsidies was adopted. Facility of providing subsidies for power started way back during the British rule and continued during post-independence era. The objective behind these subsidies was to reform the agriculture sector and to provide relief to the poorer sections of the society (Gupta,2013). To popularize the tubewell irrigation for better production, government-owned state power utilities aggressively persuaded unwilling farmers to install electric tubewells. In the period of 1950s, raising energy consumption was considered synonymous with economic progress and loans and concessions were made available to farmers. In Indian states like Punjab and Uttar Pradesh, the Chief Ministers set steep targets to district-level officials to sell electricity connections to farmers to popularize tubewell irrigation (Shah *et.al*., 2007).

Similarly, during the 1960s and the 1970s, the World Bank supported huge investments in rural electrification infrastructure to stimulate groundwater irrigation and agricultural growth. The state governments have enacted a series of policies including the subsidization of key agricultural inputs in the 1960s. These policies were vindicated when the *Green Revolution* succeeded the tubewell revolution. An agricultural electricity subsidy was implemented to encourage groundwater irrigation. Indeed, this subsidy increased agriculture's share of energy use, which jumped from just 3% of total energy use to 14% by 1978 (Badiani, 2010; Pachauri, 1982).

On these grounds, state bodies at both national and regional levels heavily promoted groundwater use as a shortcut to agrarian modernization. Whereas projects aimed at increasing the scope of canal irrigation have slowed or stagnated across most of rural India, successive governments at regional and national levels have encouraged drilling of private wells through the extension of credit and also by subsidizing the electricity used by pumpsets (Taylor, 2013). First of all, ground water development is subsidized through the National Bank for Agriculture and Rural Development (NABARD) which provides refinancing facilities to other banks to support loans for private wells and pumps. Second, electricity is priced at subsidized rates for irrigation pumping. On the other side, NABARD runs a variety of credit programmes which substantially subsidizes well-development by individuals. Electricity subsidies probably have a larger effect on ground water development than credit availability. In most areas, electricity for pumping ground water is sold at a flat annual rate based on pump horsepower or provided free of charge(Monech, 1992).

Though target of food security has been achieved, these policy measures have created mono-cropping pattern and lock-in situation for cereal crops and oil seeds. The other negative impact of the Minimum Supporting Prices is the inequitable distribution of subsidies due to concentration of procurement in just two food grains and selected states. In 2003-04, nearly 95% of the wheat was procured from Punjab, Haryana and part of Uttar Pradesh. Similarly, nearly half of the paddy procurement was made from the states of Haryana and Punjab, followed by Andhra Pradesh and Chhattisgarh. Not only farmers in these selected states draw the benefits of the subsidies, within these states mostly the large farmers enjoy these benefits leaving out small and marginal farmers,. Study in Andhra Pradesh has shown that farmers, notably small and marginal, face several hurdles in realizing the MSPs offered by the government (Sinha *et.al.*, 2006). Policy issues such as those dealing with groundwater, agriculture and energy have created a nexus between groundwater and energy in India. Thus, Agricultural policies, especially the procurement policies are such that they have encouraged farmers to continue growing more water-intensive crops (rice, sugarcane etc.). This further promoted the politics of free electricity and political populism in the energy sector (Sinha *et.al.*, 2006).

The rise of groundwater irrigation also transformed the organization of irrigation at the local level. In pre-Colonial India, co-operation at the community level was the dominant institution for irrigation. Under the colonial rule, collaboration between the State and the engineering profession was at the centre-stage of centralized, bureaucratic irrigation development and management. In this new era of atomistic irrigation, the State as well as science became onlookers in a ballgame whose rules and logic they did not understand, much less dictate. In an incipient atomistic irrigation economy of the 1980's and later, neither the State nor the community was the entrepreneur, builder, or the manager of irrigation; it was the multitude of small-holders Marx's 'millions of disconnected production units' each with his tiny, captive irrigation system, ostensibly unconnected with the rest (Shah, 2009).

Between 1960 and 1985, India invested in irrigation projects several times more capital in real terms than the British had invested during the 110 year period between 1830 and 1940. However, even according to the Government of India's figures, over 60 percent of irrigated areas are today served by groundwater. Until 1960, Indian farmers owned just a few thousands

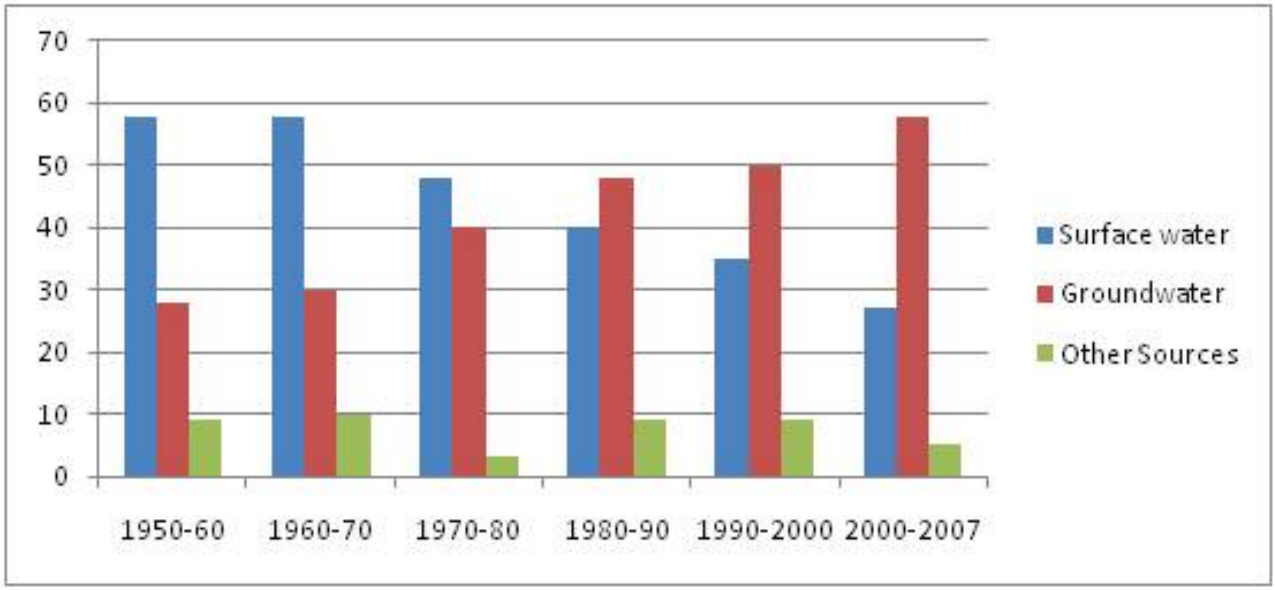
of mechanical pumps using diesel or electricity to pump water; today India has over 20 million modern water extraction structures. Every fourth cultivator household has a tube well; and two of the remaining three use purchased irrigation service supplied by tube well owners (Shah, 2006). Groundwater irrigation has also ensured food security and helped alleviate poverty. India, for instance, was declared a 'basket case of hunger' and if the doomsday prediction of the neo -Malthusians were to become true, India's population would have hungered to death some two decades or so ago. Only instead, today India has a burgeoning grain reserve of over 60 million and annual grain production touched a record high. Entirely thanks to the groundwater economy. (Mukherji and Shah, 2005).

GROUNDWATER CONTOURS AND THREAT TO FOOD SECURITY

In present scenario, groundwater has emerged as a precious natural resource essential for growth in India's rural areas. It is a vital resource in rural areas as fact emerges that 85% of India's rural domestic, 50% for urban water requirement and more than 50% requirement is fulfilled from ground water (Jha and Sinha,2009).

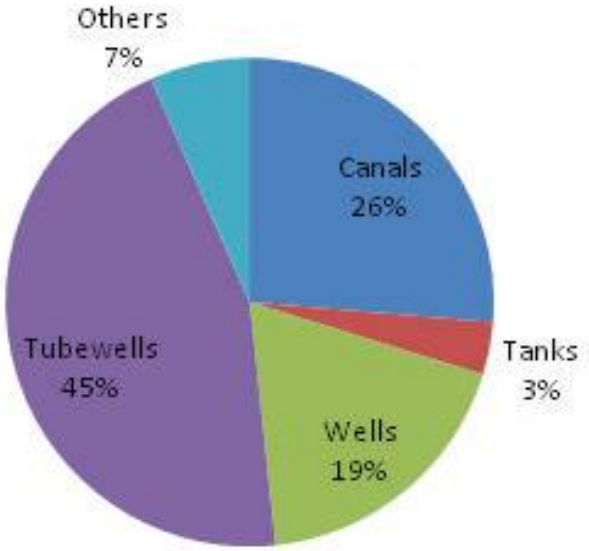
Over and above, this resource is not like canal irrigation wherein investment is mainly from the State side and access is restricted by topographic constraints. Over-dependency over groundwater has changed the shape of groundwater irrigation in India that may threaten food security target for the future. It can be further gleaned from the facts that the pace of growth of shallow and deep tubewells during 1980s was 7.2 and 5.3 percent as against a meager 1.8 percent of digging wells. Table 1 and Table 2 depict how irrigated area under canal irrigation has declined but area of groundwater irrigation has increased between 1950 to 2007.

Table 1: Decade wise Share of Surface Water and Groundwater in Net Irrigated Area (%)



Source: *Indian Agricultural Statistics,* cited in Shankar et.al, 2011; p.38

Table 2: Area Irrigated by Different Source of Irrigation (by Size Class) 2010-11



Source: *Agricultural Statistics at a Glance 2014.* Ministry of India

In assessing the reason behind these decline, reports by experts of the Central Ground Water Board have stated that growing pace of urbanization and industrialization in the over-exploited region is one of the major reason. Further, water intensive crops with higher remunerative prices have tended to be grown even in respect of scarcity of groundwater and also decided on the cropping pattern that predominately determines agriculture demand for groundwater.

Table 3: Categorization of Blocks/ Mandals/ Taluks in India on Ground Water Exploitation

	States	Total No. of Assessment Units	Safe		Semi Critical		Critical		Over-Exploited	
			Nos.	%	Nos.	%	Nos.	%	Nos.	%
1	Andhra Pradesh	1108	867	78	93	8	26	2	84	8
2	Arunachal Pradesh	16	16	100	0	0	0	0	0	0
3	Assam	23	23	100	0	0	0	0	0	0
4	Bihar	533	529	99	4	1	0	0	0	0
5	Chhattisgarh	146	132	90	14	10	0	0	0	0
6	Delhi	27	2	7	5	19	0	0	20	74
7	Goa	11	11	100	0	0	0	0	0	0

8	Gujarat	223	156	70	20	9	6	3	27	12
9	Haryana	116	18	16	9	8	21	18	68	59
10	Himachal Pradesh	8	6	75	0	0	1	13	1	13
11	Jammu & Kashmir	14	14	100	0	0	0	0	0	0
12	Jharkhand	208	200	96	2	1	2	1	4	2
13	Karnataka	270	154	57	34	13	11	4	71	26
14	Kerala	152	126	83	22	14	3	2	1	1
15	Madhya Pradesh	313	224	72	61	19	4	1	24	8
16	Maharashtra	353	324	92	19	5	1	0	9	3
17	Manipur	8	8	100	0	0	0	0	0	0
18	Meghalaya	7	7	100	0	0	0	0	0	0
19	Mizoram	22	22	100	0	0	0	0	0	0
20	Nagaland	8	8	100	0	0	0	0	0	0
21	Orissa	314	308	98	0	0	0	0	0	0
22	Punjab	138	23	17	2	1	3	2	110	80
23	Rajasthan	239	31	13	16	7	25	10	166	69
24	Sikkim	4	4	100	0	0	0	0	0	0
25	Tamil Nadu	386	136	35	67	17	33	9	139	36
26	Tripura	39	39	100	0	0	0	0	0	0
27	Uttar Pradesh	820	605	74	107	13	32	4	76	9
28	Uttarakhand	17	11	65	5	5	29	1	6	0
29	West Bengal	269	231	86	38	14	0	0	0	0
	Total States	5792	4235	73	518	9	169	3	800	14

Source : Ground Water Year Book 2012-2013 (Central Ground Water Board)

Table 3 indicates that out of 5792 numbers of assessed administrative units (Blocks/ Taluks/ Mandals/ Districts) by the Government of India, 800 units were found to be Over-exploited, 169 units in Critical state, 518 units Semi-critical, and only 4235 units as Safe. Apart from these, there are 70 assessment units which are completely saline. Data is also reveling the points that the number of Over-exploited and Critical administrative units are significantly higher (more than 15% of the total assessed units) in Delhi, Gujarat, Haryana, Himachal Pradesh, Karnataka, Punjab, Rajasthan and Tamil Nadu and also the UTs of Daman & Diu and Puducherry. This is also indicating the alarming fact that the danger for food security due to groundwater depletion might occur in some states of India. Groundwater depletion is encountered both in the alluvial areas i.e. Punjab, Haryana, and Gujarat mainland and in the hard rock areas .i.e. Tamil Nadu,

Karnataka and Saurashtra region of Gujarat (Kumar, 2010).Therefore, it is also observed that depletion of groundwater in some states would affect national food production and would also change the farmer's preference from cereals to less water-consuming and high-risk cash crops. Threat for food security can be precarious in states like Rajasthan and Gujarat where most of the areas are over-exploited for ground water and surface water is extremely limited.

Dilemma of ground water resource does impact the socio-economic status of farmers in Indian states. Joshi and Acharya (2005) have noted a new emerging trend in Indian agriculture and ground water regime. An unequal access to groundwater in North Gujarat has been studied by them. According to them, thousands of small and marginal farmers are deprived of direct access to groundwater in the north region of Gujarat. But the rich well-owners continue to enjoy unlimited access to groundwater using heavily subsidized electricity. This clearly indicates that subsidy is cornered by large farmers who own tubewells (solely or jointly) and sell water to the small and marginal farmers and no restriction on these water markets is in force. Owners of the land and tube wells automatically become the owner of the water wealth beneath the land and they keep selling this water. Further it has also been found that tubewell technology has become a business instrument for many rich farmers and rich farmers are giving preference to water market that is more profitable for them and this has happened due to power subsidy. Janakrajan (1994) have examined how groundwater depletion has created the institution of water market in water scarce states. This type of water market is creating water overlords who pander different type of authority to sustain or deplete groundwater resource.

On the other hand, the growing population demands more food while farmers are giving preference to grow water-intensive cash crops. It is noted that while earlier goal of India's agricultural was to produce more and more wheat and rice and currently millions of farmers are investing in maintaining the current system. This also creates the policy challenge of crop diversification to curb other associated environmental issues. In many parts of India, especially in the northwestern states of Punjab, Haryana, and western Uttar Pradesh, continued wheat and rice cultivation using intensive inputs cannot be sustained because of rapidly depleting water tables, as well as increasing soil salinity and micro-nutrient deficiencies caused by overuse of government subsidized nitrogenous fertilizers (Witsoe, 2006).

Hard rock areas contribute to India's food security in a major way. For instance, nearly 51.5% of India's total rice production comes from the five states that are falling under hard rock category, and which are facing negative consequences of overexploitation. More importantly, Andhra Pradesh and Tamil Nadu, which are experiencing over-exploitation problems, account for 20.2 % of India's rice production. Hence, the impact of depletion in hard rock areas on food security would be remarkable (Kumar et.al.2010). Thus, changes in the shape of groundwater irrigation threaten our future food security if viable options are not opted in agrarian states.

POLICY IMPLICATIONS AND CONCLUDING REMARKS

In India, 22% of GDP comes from agriculture sector and it supports 58% of the population. Thus, Agriculture has been the backbone of the economy and social development. Rational pricing policies and sustainable management of natural resources were neglected in India for

food sufficiency. In Agriculture Sector, high subsidized inputs and public investment of two crops- paddy and wheat- that are extremely water intensive imposed a pressure on groundwater. Even the indirect policies like energy and crop diversification can be helpful in arresting the problem of groundwater depletion. On the other side, one can say that the present scenario of groundwater realities in India presents a critical picture No single policy intervention can solve this problem and hopefully energy policies with political compulsions can play a role in properly handling the nexus between food security and groundwater resource.

Managing groundwater for food security requires a multipronged approach and irrigation need to be balanced for the future. There is need for proper water supply management, proper water allocation, farmer's reasonable ground on usages of groundwater and government's strong will to handle this nexus. In water abundant regions such as Bihar and Orissa, the poor still depend on the water for irrigation and purchase at prohibitive prices. On the other side, some states have rich alluvial aquifer, and those are depending on groundwater irrigation. Mukherjee (2003) and Shah (2001) states that informal water markets, water harvesting and artificial recharging can be good institutional mechanisms to promote access equity in groundwater irrigation. Water management is critical to India's agriculture sector before more and more areas turn saline and make living and farming a major challenge.

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