We sincerely thank the anonymous reviewer 2 and appreciate his/ her efforts in providing critical comments for the improvements of our contribution. Here, we present our responses to the comments.

A. The choice of the Topic:

(i) the authors have tried to link the food-energy security with groundwater availability based on past data over Indian region. The study area is really important and it is important bring out/highlight the link in presence of climate stress. Having said so, it is quite disappointing the manner the topic is described. Authors can't clarify the relevance of the metric used for validation of the results. For example the computation of ground water from GRACE satellite data is really not convincing as the results barely correlate with the directly measured groundwater data Fig.3(c,e,g).

We thank the reviewer for pointing out the importance of the case study area.

We appreciate the comments related to the validation of GRACE derived groundwater storage information. Firstly, we would like to present a series of scientific studies that have used the GRACE derived water storage data for the case study region. This table will now be added as a part of the Supplementary Material.

Table R1

Reference	Case-study Region	Source
Rodell, M., Velicogna, I. and Famiglietti, J. S.: Satellite-based estimates of groundwater depletion in India., *Nature*, 460(7258), 999–1002, doi:10.1038/nature08238, 2009.	North-West India (Punjab, Haryana, Delhi, Rajasthan)	http://www.nature.com/nature/journal/v460/n7258/pdf/nature08238.pdf
Tiwari, V. M., Wahr, J. and Swenson, S.: Dwindling groundwater resources in northern India, from satellite gravity observations, *Geophys. Res. Lett.*, 36(18), 1–5, doi:10.1029/2009GL039401, 2009.	Indus-Ganga-Brahmaputra Basin.	http://onlinelibrary.wiley.com/doi/10.1029/2009GL039401/epdf
Chen, J., Li, J., Zhang, Z. and Ni, S.: Long-term groundwater variations in Northwest India from satellite gravity measurements, *Glob. Planet. Change*, 116, 130–138, doi:10.1016/j.gloplacha.2014.02.007, 2014.	North-West India	http://ac.els-cdn.com/S0921818114000526/1-s2.0-S0921818114000526-main.pdf?_tid=b0e17334-e9d5-11e6-9328-00000aab0f02&acdnat=1486101648_83a007a750a5b266c5a402b016f1bfa2

Dasgupta, S., Das, I. C., Subramanian, S. K. and Dadhwal, V. K.: Space-based gravity data analysis for groundwater storage estimation in the Gangetic plain, India, *Curr. Sci.*, 107(5), 832–844, 2014.	Gangetic Plain (Uttar Pradesh, Bihar, West Bengal)	http://www.currentscience.ac.in/Volumes/107/05/0832.pdf
Prakash, S., Gairola, R. M., Papa, F. and Mitra, A. K.: An assessment of terrestrial water storage, rainfall and river discharge over Northern India from satellite data, *Curr. Sci.*, 107(9), 1582–1586, 2014.	India	http://www.currentscience.ac.in/Volumes/107/09/1582.pdf
Khandu, Forootan, E., Schumacher, M., Awange, J. L. and Müller Schmied, H.: Exploring the influence of precipitation extremes and human water use on total water storage (TWS) changes in the Ganges-Brahmaputra-Meghna River Basin, *Water Resour. Res.*, doi:10.1002/2015WR018113, 2016.	Ganga-Brahmaputra-Meghna Basin	http://onlinelibrary.wiley.com/doi/10.1002/2015WR018113/epdf
Yi, S., Sun, W., Feng, W. and Chen, J.: Anthropogenic and climate-driven water depletion in Asia, *Geophys. Res. Lett.*, doi:10.1002/2016GL069985, 2016.	Asia	http://onlinelibrary.wiley.com/doi/10.1002/2016GL069985/epdf
Panda, D. K. and Wahr, J.: Spatiotemporal evolution of water storage changes in India from the updated GRACE-derived gravity records. *Water Resources Research*, *52*(1), 135-149, 2016.	India	http://onlinelibrary.wiley.com/doi/10.1002/2015WR017797/epdf
Asoka, A., Gleeson T., Wada Y. and Mishra, V.: Relative contribution of monsoon precipitation and pumping to changes in groundwater storage in India. *Nature geoscience*, 10, 109–117, doi:10.1038/ngeo2869, 2017	India	http://palgrave.nature.com/ngeo/journal/v10/n2/pdf/ngeo2869.pdf

Further to this, we would like to respectfully point out that the well data available from CGWB are not continuous and the sample size is also low. Under such situation, with spatially and temporally discontinuous ground observations, a high correlation may not be expected. However, except one region (NWI), we have got statistically significant correlation between GRACE derived storage and well depth data (p-value < 0.05) and this justifies the use of GRACE for the present study to estimate groundwater storage.

The above discussion will be added in the revised manuscript in Sect 4.2.

(ii) Topic wise, the manuscript is an intermediate between a policy report and scientific hypothesis (e.g calculation of Groundwater from GRACE vs comparing the growth of agriculture in recent decade). I believe the scientific rigorousness of the presentation is missing (and is compromised while writing). HESS mostly is a scientific reporting journal and not a policy reporting journal, hence manuscript is not suitable for publication in this journal or else require a thorough revision. The revision may be focused on explaining a particular science topic (e.g. evaluation of GRACE derived GW data with other observation)

We respectfully disagree with the reviewer. We strongly feel that one of the purpose of scientific studies related to water is to help the community in planning for sustainable water management through policy reforms specifically for the regions which are severely affected by anthropogenic activities. We also would like to quote few lines from the objectives of the present special issue of HESS:

"Contributions are invited on various aspects of the study of the hydrological and hydrogeological processes, subsurface–surface–climate interactions, water resources and risks, socio-hydrological interactions, and the relationship between the water cycle and human development."

"The Ganges basin in particular exhibits extreme hydrological behaviour, including but not limited to the extent of human irrigation, the size and human use of its groundwater resources, the speed of land-use change, and the magnitude and seasonality of the Indian monsoon."

We also present an article from HESS on a similar topic but for different case study region.

Scott, Christopher A., et al. "Irrigation efficiency and water-policy implications for river basin resilience." *Hydrology and Earth System Sciences* 18.4 (2014): 1339.

Further to this, we also quote the comments from the other reviewers:

Reviewer #1:

"This is a timely and relevant contribution to the scientific literature and to broader understanding of water-energy-food nexus dynamics in India"

Reviewer #3:

"The work touches on a very interesting and relevant topic."

Hence, we would like to keep the focus of the manuscript unchanged.

B. Presentation

(iii) The manuscript is very poorly written and it lacks of focus, especially in the introduction where the so called food-energy nexus is introduced. The whole introduction requires a complete restructuring in order to have a clear focus.

In the first version of the manuscript the introduction was structured in the following way:

Introduction to water-food-energy nexus → Introduction to scenarios in India → Background hydro-climatic patterns in India → Literature focussing on changes in water resources → research gap and development of hypothesis.

However, we agree that there are certain limitations in the initial write up in terms of absence of definition of water food and energy security, linkages between the paragraphs etc. We will modify the same.

(iv) The term "Water-Food-Energy Nexus" is really not a suitable or scientific term to use; especially "nexus" is term quite confusing as the word implies a causative connection which is not reflected here. The study at best hypothesizes a chain of unconnected events linked together. For example, from Fig.1, the "increase in food price" is not always directly linked to "food security". Similarly "pumping of ground water" is not always linked to "irrigation". The whole chain in fig.1 is very qualitative.

We respectfully disagree that water-food-energy nexus is not a scientific term. Here we present a list of scientific article that use the term:

Table R2:

Reference	**Source**
Hoff H. Understanding the nexus: Background paper for the Bonn2011 Nexus Conference.	http://wef-conference.gwsp.org/fileadmin/documents_news/understanding_the_nexus.pdf
Jakob Granit , Anders Jägerskog , Andreas Lindström , Gunilla Björklund , Andrew Bullock , Rebecca Löfgren , George de Gooijer & Stuart Pettigrew (2012) Regional Options for Addressing the Water, Energy and Food Nexus in Central Asia and the Aral Sea Basin, *International Journal of Water Resources* Development, 28:3, 419-432, DOI: 10.1080/07900627.2012.684307	http://www.tandfonline.com/doi/pdf/10.1080/07900627.2012.684307?needAccess=true
FAO: The Water-Energy-Food Nexus - A new approach in support of food security and sustainable agriculture, Food Agric. Organ.	http://www.fao.org/nr/water/docs/FAO_nexus_concept.pdf

United Na, 1–11, doi:10.1039/C4EW90001D, 2014.	
WADA, Christopher A; BURNETT, Kimberly; GURDAK, Jason *J. Sustainable Agriculture Irrigation Managemen*t: The Water-Energy-Food Nexus in Pajaro Valley, California. Sustainable Agriculture Research, [S.l.], v. 5, n. 3, p. p76, may 2016. ISSN 1927-0518. doi:http://dx.doi.org/10.5539/sar.v5n3p76.	http://ageconsearch.umn.edu/bitstream/241747/2/P7-p76-83.pdf
Endo, A., Tsurita, I., Burnett, K. and Orencio, P. M.: A review of the current state of research on the water, energy, and food nexus, *J. Hydrol. Reg. Stud*., doi:10.1016/j.ejrh.2015.11.010, 2015.	http://ac.els-cdn.com/S2214581815001251/1-s2.0-S2214581815001251-main.pdf?_tid=38adc236-e9ef-11e6-9eec-00000aab0f01&acdnat=1486112614_472590260796ab6befe2c4830ebc7640
Gurdak, J.J., Geyer, G.E., Nanus, L., Taniguchi, M., and Corona, C.R., 2016, Scale dependence of controls on groundwater vulnerability in the water-energy-food nexus, California Coastal Basin aquifer system, *Journal of Hydrology: Regional Studies*, special issue on the Water-Energy-Food Nexus of the Asia-Pacific.	http://www.sciencedirect.com/science/article/pii/S2214581816000057
Hatfield-Dodds, Steve, Heinz Schandl, Philip D. Adams, Timothy M. Baynes, Thomas S. Brinsmead, Brett A. Bryan, Francis HS Chiew et al. "Australia is 'free to choose'economic growth and falling environmental pressures." *Nature* 527, no. 7576 (2015): 49-53.	http://www.nature.com/nature/journal/v527/n7576/pdf/nature16065.pdf
Taniguichi, M., Endo, A., Gurdak, J.J., and Swarzenski, P., 2016 - In Review, Water-Energy-Food Nexus in Asia Pacific Region, *Journal of Hydrology: Regional Studies*, special issue on the Water-Energy-Food Nexus of the Asia-Pacific Region.	

We agree that Figure 1 hypothesised the possible causative connection between different components of water-food-energy system specifically for Indian context and this has been further tested statistically with different datasets. Hence, the use of the word "nexus" is justified.

We also agree that there are multiple reasons associated with food security and one of them is increase in food price. This causal connection is relevant to water food energy nexus in India. Similarly, pumping of groundwater has multiple uses (domestic and industrial) but the major use (91%) is in terms of irrigation (CGWB, 2014). Figure

2(f) confirms the same showing wells as the major source of irrigation for net irrigated area for all-India. The above mentioned discussions will be added in the revised manuscript in Sect.1 along with Fig.1.

C. Results and Data

(v) Estimation of ground water based on Grace and GLDASS model result is not convincing as it includes many uncertainties (which authors themselves have agreed). There is no effort made by the authors to quantify the uncertainties.

We have agreed that significant uncertainty exist in the GRACE derived groundwater storage and have presented in the earlier version in terms of bands (in Fig. 4c). We will be revising the figures 4c showing individual members to explain the uncertainty along with Supplementary Figures S2, S5 and S8. The revised figures are presented below:

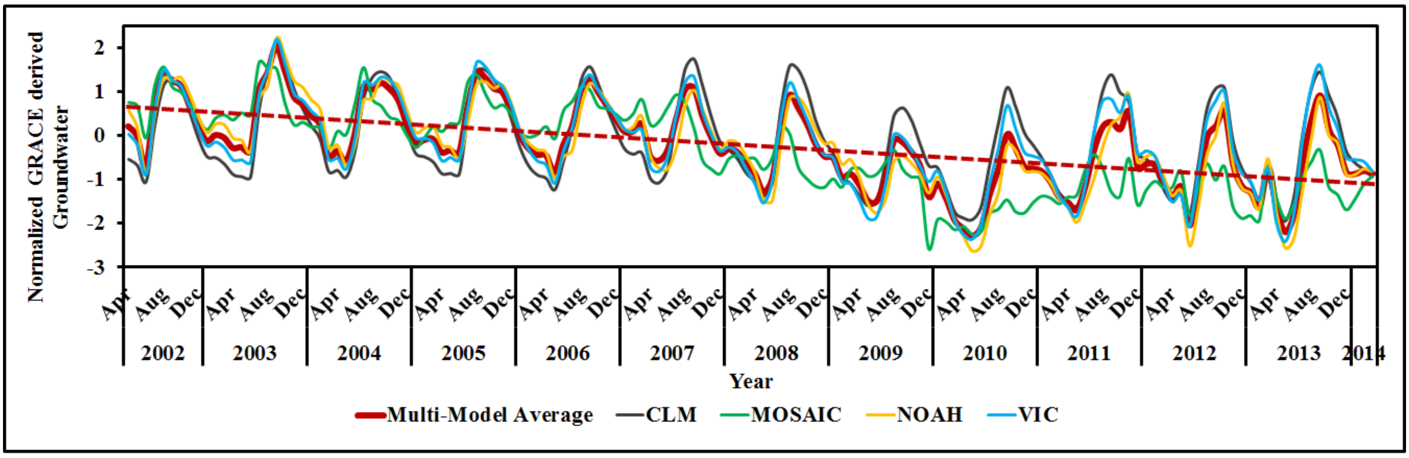

Fig. R1. Declining GRACE-GLDAS derived groundwater storage anomaly for India (modified version of Fig 4(c))

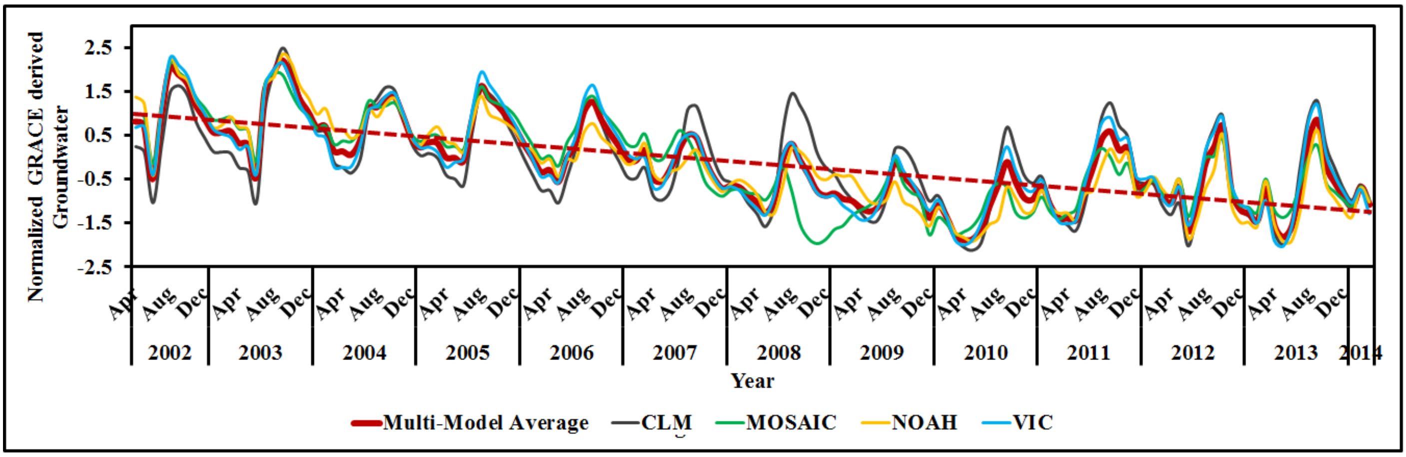

Fig.R2. GRACE-GLDAS derived groundwater storage anomaly for MGB. (modified version of Supplementary Fig S2)

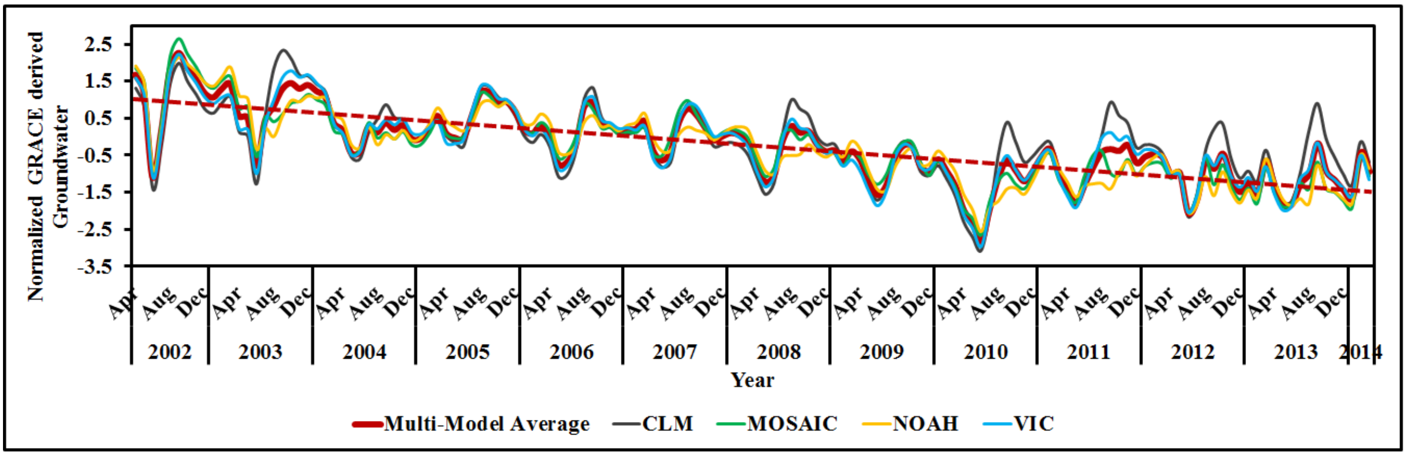

Fig.R3. GRACE-GLDAS derived groundwater storage anomaly for NWI. (modified version of Supplementary Fig S5)

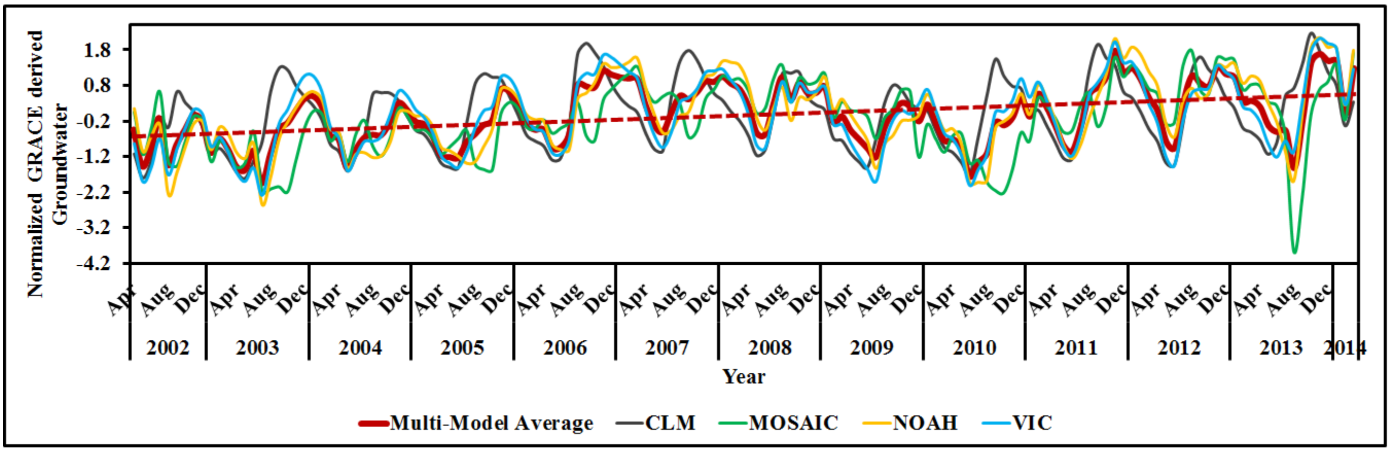

Fig.R4. GRACE-GLDAS derived groundwater storage anomaly for WCI. (modified version of Supplementary Fig S8)

The following sentences will be added for India and each of the sub-regions (MGB, NWI and WCI) in Sect. 4.3.1, Sect.4.4.1, Sect. 4.4.2 and Sect. 4.4.3 respectively to bring out the uncertainty.

Figure R1 shows the GRACE-GLDAS derived groundwater storage for India. The red line represents the multi-model average, which has a significant negative trend (p-value:2.02×10^{-13}). VIC and NOAH has the least deviation from the mean, whereas CLM and MOSAIC has a larger deviation resulting in an increased uncertainty.

Figure R2 shows the GRACE-GLDAS derived groundwater storage for MGB. Similar, to the analysis for India, here the derived groundwater also shows a statistically significant negative trend (p-value: 2.58×10^{-21}). Deviations for the simulations from MOSAIC and CLM are higher than those from VIC and NOAH. Both, MOSAIC and CLM derived groundwater shows a higher deviation specifically around the year 2008-09.

Figure R3 shows the GRACE-GLDAS derived groundwater for NWI. Here as well the multi-model average line has a significant negative trend (p-value: 6.79×10^{-29}). The uncertainty is low compared to the other regions.

Figure R4 shows the GRACE-GLDAS derived groundwater for WCI. The multi-model average has an increasing positive trend (p-value: 2.1×10^{-7}). MOSAIC derived groundwater has a higher deviation from multi-model average through the entire study period.

(vi) A lot of trends has been plotted. Firstly "http://eands.dacnet.nic.in/PDF/PocketBook2014.pdf/" is not accessible online on 2/2/2017 when I have reviewed the manuscript. Even if it is available I am not quite sure how such a data can be trusted for scientific studies. It could be good for policy "outlooks" only but unless some peer reviewed publications are available some of the results are not acceptable. For example refer Fig.6c. How do you think that there is any causal relationship between total food production and electricity consumption? How Electricity consumption is separated from agricultural use vs. other rural use e.g. commercial agro-based industries (sans requirement of irrigation) use?

The corrected site is http://eands.dacnet.nic.in/PDF/Pocket-Book2014.pdf

The "/" at the end of the weblink does not allow to access the website. We will correct it in the revised manuscript and sincerely apologize for this inadvertent error.

The data is from Department of Agriculture, Government of India and hence it is reliable.

We also would like to clarify that this is the agricultural electricity consumption and not total electricity consumption. This was explicitly mentioned in the earlier version of the manuscript (Abstract, line 26).

(vii) Just providing correlation and trends does not show some causative evidence (may be it is useful for social references)

Computations of correlation and trends are scientific and statistical methods to be applied for any study irrespective of the focus of the study, societal or technical.

(ix) Fig.4(b) and (d) is a statement of unreliability of the GRACE data in correlating with AIMR for the link you are trying to establish.

We would like to point that Fig. 4 (b) and (d) do not show the unreliability of the data; rather they show the importance of human interventions in the water cycle that reduce the correlation. This is a very important figure and the first reviewer has appreciated the same:

"The findings from analysis of GRACE data as well electricity usage being uncorrelated to monsoon rainfall are novel and should be highlighted."

F. Conclusion like introduction, the section on conclusion also has no new scientific result. Even no new policy decision support system has been suggested (those which are suggested are already in place)

We agree and thank the reviewer for pointing this out. We have modified the conclusions following the suggestions from all the reviewers.

We will elaborate on the following proposed methodologies that may be adopted for judicious regulation and control.

- **Soil Moisture Monitoring and irrigation practice:** Uncontrolled use of groundwater for irrigation attributes to the lack of monitoring of soil moisture and hence the irrigation practices in India are not demand driven. Recent studies (Devineni et al., 2012; Devineni et al., 2013 and Fishman et al., 2015) show that the application of irrigation based on soil moisture condition may result into conversion of significant area from water stressed to water surplus. Further to this, the irrigation practice in India is largely flood irrigation, which has very low efficiency. Changing of irrigation type from flood to drip may reduce significant water wastage and improve irrigation efficiency.
- **Considering seasonal and extended range forecast for better water consumption:** In India, the agricultural water management models exists in theory, but they are seldom used in practice. An agricultural water allocation model at a fortnight scale or at a seasonal scale considering the improved seasonal (Saha et al., 2012) and extended range forecast (Sahai et al., 2013; Shah et al.,2016) may be useful and this needs to be further explored in near future.
- **Tariff determination based on seasonal prediction (varying volume of water usage):** Based upon seasonal prediction, a farmer would be made aware of a good/bad/normal monsoon year. Demands should be calculated based on seasonal prediction and accordingly the required amount of groundwater irrigation may be obtained considering possible margin of errors from hind-cast data. This amount may be considered as an upper limit for the famers to be used freely or at a subsidized tariff. If this upper limit is crossed, then they would not be allowed to enjoy free water and cheap electricity. This would majorly reduce the over-exploitation of groundwater.
- **Groundwater usage metering:** Electricity has been made available at a subsidised rate (almost free), increasing the accessibility of groundwater (Badiani et al.,2012; Fishman et al., 2015). If a volumetric tariff on groundwater (Shah et al., 2004) usage at a local level or at least at a district level is put in place it would also help in estimating the groundwater abstraction and accordingly management of the same.
- **Water allocation and water pricing:** Water allocation system needs to be put in place depending on the productivity and yield of crops (Huh and Lall, 2013). Water allocation and pricing should follow an optimal cropping policy (Devineni et al.,2012). Cultivation should be carried out in an area where it is best suited for a specific crop. Hence, reducing the pressure on the resources to produce the crop.
- **More production of food grains rather than cash crops:** Farmers have an inclination of producing cash crops than food grains as they are economically more lucrative. Food grains have a minimum price policy that is fixed by the government, hence profit maximisation is low. Moreover, most of the cash crops used are water intensive. Policy interventions are required to manage the same for a sustainable water and food security.

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