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Natural resource management for enhancing farmer's income: An optimal crop planning approach in Bihar

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ABSTRACT

To maximize the income of farming community of the state and also to maintain the nutritional demand of an ever-increasing population, it is important to optimize the use of available land and water resources. An attempt has been made to revise the existing cropping pattern using linear programming considering land and groundwater as constraints. Data of Comprehensive Cost of Cultivation Scheme, Ministry of Agriculture and Farmers Welfare, GOI for the block year 2008-11 for Bihar was used to estimate the net returns at market price (MP), economic price (EP) and natural resource valuation (NRV) for obtaining an optimum crop plan. The optimal crop plan at existing groundwater use revealed the decline in gross cropped area (GCA) by -1.41% of existing GCA of the state. Few crops like paddy, wheat, ragi, sunflower and jute recorded declining trend in its area probably because of large water consuming crops. When groundwater use was increased by 25% of the existing GW use, the optimal crop plan indicated increase in GCA by 15.73% with respect to existing GCA. The level of profit would be earned more by 9% in optimum crop plan as compared to existing optimum crop plan. The optimum crop plan could be profitable and successful, when water development is further enhanced coupled with cheap source of irrigation facilities (electric and solar operated devices) made available to the farming community.

Key words: Economic price (EP), Groundwater, Market price (MP), Natural resource valuation (NRV), Optimization

Bihar agriculture is facing many challenges, viz. shrinking net sown area, non-availability of quality seeds, major irrigation through diesel pump sets (more costly), inadequate storage facilities, inadequate processing industries for agricultural produces, poor marketing infrastructure, scarcity of labour as well as erratic behavior of monsoon etc. (Bharti *et al*. 2014). The groundwater availability in Bihar is 26.27 BCM out of which only 10.26 BCM is drafted for irrigational purposes (CGWB 2011). The groundwater development is only 44% in the state; this means that only 44% of available groundwater is utilized for irrigating the crops. On the other hand, it is noted that the net sown area in the state has shrunken over the time. It has been observed almost stagnation in the productivities of almost crops grown in the state. Due to erratic nature of monsoon mostly during first decade of the present century, the water table is going down in different parts of the state. The areas under almost crops except wheat, maize, sugarcane and potato, have declined over the period under study. The productions of most of the crops were found to be remaining stagnant. Under these conditions, the question here arises 'how to maximize the income of the farming community of the state out of shrinking net sown area with the use of cheap sources of energy for groundwater extraction, i.e. electric or solar energy which are comparatively cheap than diesel energy. Further, repairing and maintenance and expansion of surface irrigation system (canal) are very much essential for augmenting irrigation, recharge of groundwater as well as lessen the dependency on worsening weather situation.

To meet the growing need of nutritional security to an increasing population, it is necessary to bring more area under cultivation or increase production per unit area of available cultivable land and water resources (Dahiphale *et al.* 2015). In states like Bihar, there is a growing need to increase the income and employment of the farmers, through optimal crop planning (Singh *et al*. 1990). Overall development of the state depends on agriculture as it is the backbone of the state economy (Singh *et al*. 2015). Agriculture depends on land and water. Due to urbanization

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and a reluctance to disturb environments, there is difficult task to bring the additional land under agricultural uses. Hence, it is important to optimize the available land and water resources to achieve maximum production (Rani and Rao 2012). This requires proper planning and management process of land and water resources and appropriate use of available technologies.

Here effort is being made to maximize the income of the cultivators from raising the crops, considering the important constraints, viz. land constraints and water constraints. Land constraint uses allocation of the minimum and maximum area for each crop grown in the state, assuming the considerable area under major staple food crops (paddy, wheat and maize etc.) from the food security point of view in the state (Singh *et al*. 1990). An attempt has been made in this paper, to revise the existing crop plan using linear programming considering land and water as constraints.

MATERIALS AND METHODS

Present study is based on farm-wise data collected under Comprehensive Cost of Cultivation Scheme (CCCS), Ministry of Agriculture and Farmers' Welfare, Government of India, running in Bihar. Secondary data for area of different crops were collected from various issues of Economic Survey of Bihar and Bihar Through Figures. Data regarding groundwater use was obtained from the Annual Report of Central Groundwater Board, Patna.

The performance of different crops was assessed by computing net returns under alternative scenarios. The alternative scenarios are (i) Market prices; (ii) Economic prices net of subsidies; and (iii) Net income based on natural resource valuation technique (NRV) (Raju *et al.* 2015). For cost-return analysis of various crops grown in Bihar, the primary data concerning cost and returns for 450 sample farmers were obtained from Comprehensive Cost of Cultivation Scheme for the block year, 2008-11 for the state of Bihar.

Besides this, input-output data were also generated through survey of few crops like cabbage, cauliflower, tomato, chilli, sunflower, linseed, barely, ragi, kulthi (horse-gram) and onion for the year, 2014-15 and further cost and returns for the above crops were deflated to 2008-11 price level.

Net returns at market prices (NR_{MP}) is defined as the gross return (value of main product and by product) less variable costs (Cost A_1+ imputed value of family labour) at market prices actually paid and received by the farmer or imputed in some cases.

$$NR_{MP} = GR - VC$$

where, NR_{MP}-Net return at market prices; GR- Gross returns; VC-Variable cost (Cost A_1).

Net return at economic prices (NR_{EP}) was defined as the difference between net return or at market prices and subsidies on inputs like fertilizers, irrigation and seed used in crop production.

i.e. $NR_{EP} = NR_{MP}$ – subsidy

Thus, subsidy component has been internalized into the model by covering three aspects, viz. fertilizers subsidy, irrigation subsidy and seed subsidy.

Fertilizer subsidy included subsidy on nitrogen, phosphorous and potassium. Fertilizer subsidy per kg was estimated at ₹ 19.347 per kg of N; ₹ 42.563 per kg of P and K for TE-2010-11. Quantity of fertilizers application for different crops under CCC Scheme for TE-2010-11 was used for calculation of subsidy on fertilizers.

Net return based on Natural Resource Valuation (NR_{NRV}) technique has taken care of nitrogen fixation by legume crops and Green House Gas (GHG) emission from crop production. Thus, NR_{NRV} is computed as by adding value of nitrogen fixation by legume crops at economic price of nitrogen and deducting the imputed value of GHG emission cost to the atmosphere.

i.e. $NR_{NRV} = NR_{EP}$ + (value of N – Cost of GHG)

The data on contribution of pulses by biological nitrogen fixation and emission from different crops were collected from various published scientific literatures, (Peoples *et al.* 1995, IIPR 2003, IARI 2014). The value of GHG emission in terms of CO_2 kg equivalent was taken at the rate of 10 US dollar per tonne. Biological nitrogen fixation for various crops has been calculated by taking the average value of nitrogen fixed by various legumes and then multiplied with the economic price of nitrogen prevailed in the TE-2010-11.

The Mathematical programming was used for developing optimum crop or land use planning. GAMES software was used to analyze the data. The present study makes an attempt to develop different crop planning strategies by using Linear Programming (LP).

Mathematical model specification for Bihar are given as under

$$Max\ Z = \sum_{c=1}^{n} (Y_c P_C - C_C)\, A_C \quad (1)$$

$$\sum_{t} \sum_{c} a_{tc} \mathrm{A_c} \le NS_{\mathrm{t}} - OA_{\mathrm{t}} \quad (2)$$

$$A_c \ge A_{min_{\mathrm{c}}} \quad (3)$$

$$A_c \le A_{max_{\mathrm{c}}} \quad (4)$$

$$\sum_{c} W_c A_c \le RGWAA \quad (5)$$

$$A_c \ge 0 \quad (6)$$

Objective function: Maximization of net income (equation 1)

$$Max\ Z = \sum_{c=1}^{n} (Y_c P_C - C_C)\, A_C \quad (1)$$

Let Y_c denotes yield of crop c in one ha of land, P the price received for the output from crop c, C_c refers to the cost incurred to cultivate crop c in one hectare of land and A_c is the area under cultivation of crop c then RHS of the equation 1 represents sum of net revenue obtained from all the crops considered for optimum model development. The objective is to maximize the net revenue (Z) based on the optimum crop plan.

Optimal use of land for each month is required, this can be achieved by having separate constraint equation (Equation 2 is a compact form of 12 equations months Jan, Feb……… Dec). This helps to have separate sown area for each month and ensures that total cultivated area under selected crops in each month should be less than net sown area (NS_t) minus area under orchard (OA_t) crops. Further, crop calendar is required for the analysis. Thus a_{tc} in equation 2 refers to the coefficients of crop calendar matrix for month and c[th] crop

Optimization of Land Constraint (equation 2)

$$\sum_t \sum_c a_{tc} A_c \leq NS_t - OA_t \tag{2}$$

In some modeling solutions, some major crops may drastically lose their relevance and the corresponding area allocation may become negligible. Then, even though estimates are robust and mathematically proven, such allocations may not be desirable and practically possible from the food and livelihood security point of view of the farming community as appropriate changes in policy framework is required only after adoption of the optimum sustainable crop model. Similarly, area for some minor crop may be overestimated ignoring the demand. To overcome such situations assigning values to minimum and maximum area is essential in the model. To eliminate such practically undesirable solutions, concept of min, max constraint is adopted in the model.

Minimum and maximum constraints (Equation 3-4)

$$A_c \geq A_{min_c} \tag{3}$$

$$A_c \leq A_{max_c} \tag{4}$$

Existing land area allocations under different crops are useful to make comparison with optimal crop plan model. The lands under different crops were collected from statistical abstract of the state. Further, this data is useful for defining the minimum and maximum area allocation limits for selected crops. Existing area under different crops are the average of three years data under the crop. Min and max area have been decided on the basis of expert advice.

Water is scare natural resource. The groundwater usage should be less than or equal to replenishable groundwater available for agriculture (RGWAA) for making the agriculture sustainable. Data regarding RGWAA is published by Central Ground Water Board. This can also be estimated by deducting water consumed by industries and other non-farm activities from total replenishable groundwater. Ground water constraint to be used in LP model is prescribed as under:

$$\sum_c W_c A_c \leq RGWAA \tag{5}$$

$$A_c \geq 0 \tag{6}$$

where, w_c is actual water drafted for a crop c in the recent year based on cost of cultivation data. A_c indicates the area allocation for a crop c. Equation-6 is the usual non-negativity constraint in the model. Regarding groundwater constraint, two situations of groundwater uses are considered such as income maximization at existing groundwater use and secondly, when the groundwater use is increased 25% more than existing level.

RESULTS AND DISCUSSION

Optimum crop model for Bihar

The study makes an attempt to develop different multi-crop plans using Linear Programming (LP) which increases the productivity with minimum input cost and ultimately getting maximum net benefits. In the state of Bihar, for the sake of practical utility, the land and water were considered as constraints in the backdrop of the fact that water development is still only 44%. Since, groundwater is available abundantly in the state, even though the pace of water development is low. Since the objective is to maximize the income of cultivators, therefore, our proposition is that the further increase in the water development from the existing level will obviously increase the gross cropped area and in turn, would raise the income of farming community. GAMES software was used to arrive at optimum crop model and the results are presented in Table 1, 2 and 3.

Table 1 indicated the optimum area allocation for crops grown in the state at different alternative prices (at existing groundwater use 10.26 BCM) and it was observed that the cropping pattern was similar in all the three prices conditions. On comparison with exiting cropping pattern, it was noted that the area under *kharif* maize, *rabi* maize, arhar, kulthi (Horse gram), gram, lentil, khesari, moong, urad, pea, rapeseed and mustard, linseed, potato, cabbage, brinjal, cauliflower, okra, tomato, onion, sugarcane and chilli tend to increase at all the three-price scenarios as compared to existing area of above crops.

On the other hand, the area under crops such as paddy, wheat, barley, ragi, sunflower and jute showed decline in their area at all three prices, probably on account of maximization of income at existing land and water situation.

It can also be perused that the optimum gross cropped area (GCA) would be reduced to 7283.48 thousand ha in all three prices conditions as compared to existing cropped area, being only 7388.00 thousand ha. The earning of optimum profit would be about 101.10 hundred crores out of the optimum crop model.

Table 2 reveals that when groundwater use is increased to 12.83 BCM, the optimum area allocation for almost all the crops included in the model showed positive direction of change in all the three prices scenarios. The gross cropped area (GCA) too increased to the level of 8550.50 thousand ha as compared to the existing GCA, being only 7388.00 thousand ha, which will certainly maximize the income of cultivators, with the condition if the groundwater development is enhanced with cheap source of irrigation facilities. It further reveals that if the cropping patterns in the state are followed in accordance with the optimum crop plan, the profit to the level of 110.90 hundred crores would be obtained out of this.

Table 1 Optimum crop model for Bihar at existing groundwater use at 10.26 BCM

Crop	Existing area ('000ha)	Optimum area ('000 ha)			Direction of change
		Market price (MP)	Economic price (EP)	Natural resource valuation (NRV)	
Paddy	3156.00	2900.00	2900.00	2900.00	---
Wheat	2106.33	2000.00	2000.00	2000.00	---
Maize (*kharif*)	232.56	250.00	250.00	250.00	+++
Maize (*rabi*)	349.69	367.98	367.98	367.98	+++
Ragi	9.90	9.00	9.00	9.00	---
Barley	11.97	10.00	10.00	10.00	---
Arhar (Red gram)	26.67	40.00	40.00	40.00	+++
Kulthi (Horse gram)	10.76	15.00	15.00	15.00	+++
Gram	58.97	70.00	70.00	70.00	+++
Lentil	173.16	200.00	200.00	200.00	+++
Khesari	83.82	85.00	85.00	85.00	+++
Moong (Greengram)	161.31	200.00	200.00	200.00	+++
Urad (Blackgram)	18.66	20.00	20.00	20.00	+++
Pea	21.35	24.00	24.00	24.00	+++
Rapeseed and mustard	86.76	110.00	110.00	110.00	+++
Linseed	23.90	25.00	25.00	25.00	+++
Sunflower	18.97	18.00	18.00	18.00	---
Potato	151.00	200.00	200.00	200.00	+++
Cabbage	38.72	40.00	40.00	40.00	+++
Brinjal	55.36	60.00	60.00	60.00	+++
Cauliflower	61.94	70.00	70.00	70.00	+++
Okra	58.31	70.00	70.00	70.00	+++
Tomato	46.57	70.00	70.00	70.00	+++
Onion	52.53	56.00	56.00	56.00	+++
Jute	123.96	120.00	120.00	120.00	---
Sugarcane	159.46	250.00	250.00	250.00	+++
Chilli	3.00	3.50	3.50	3.50	+++
GCA	7388.00	7283.48	7283.48	7283.48	---
Profit ('00 crores)				101.10	

Table 2 Optimum crop model for Bihar on increasing 25% of existing groundwater use (12.83 BCM)

Crop	Existing area ('000 ha)	Optimum area ('000 ha)			Direction of change
		Market price (MP)	Economic price (EP)	Natural resource valuation (NRV)	
Paddy	3156.00	3500.00	3500.00	3500.00	+++
Wheat	2106.33	2600.00	2600.00	2600.00	+++
Maize (*kharif*)	232.56	250.00	250.00	250.00	+++
Maize (*rabi*)	349.69	400.00	400.00	400.00	+++
Ragi	9.90	12.00	12.00	12.00	+++
Barley	11.97	15.00	15.00	15.00	+++
Red gram	26.67	40.00	40.00	40.00	+++
Kulthi (Horse gram)	10.76	15.00	15.00	15.00	+++
Gram	58.97	70.00	70.00	70.00	+++
Lentil	173.16	200.00	200.00	200.00	+++
Khesari (*Lathyrus*)	83.82	85.00	85.00	85.00	+++
Moong (Greengram)	161.31	200.00	200.00	200.00	+++
Urad (Blackgram)	18.66	20.00	20.00	20.00	+++
Pea	21.35	24.00	24.00	24.00	+++
Rapeseed and mustard	86.76	110.00	110.00	110.00	+++
Linseed	23.90	25.00	25.00	25.00	+++
Sunflower	18.97	25.00	25.00	25.00	+++
Potato	151.00	200.00	200.00	200.00	+++
Cabbage	38.72	40.00	40.00	40.00	+++
Brinjal	55.36	60.00	60.00	60.00	+++
Cauliflower	61.94	70.00	70.00	70.00	+++
Okra (Bhindi)	58.31	70.00	70.00	70.00	+++
Tomato	46.57	60.00	60.00	60.00	+++
Onion	52.53	56.00	56.00	56.00	+++
Jute	123.96	150.00	150.00	150.00	+++
Sugarcane	159.46	250.00	250.00	250.00	+++
Chilli	3.00	3.500	3.500	3.500	+++
GCA	7388.00	8550.50	8550.50	8550.50	+++
Profit ('00 crores)				110.90	

Expected gains from optimum crop plan/model

Expected gains based on optimum crop model estimated under different price situations under existing groundwater use at 10.26 BCM with reference to existing cropping pattern are presented in Table 3. It explained that under optimum crop model at existing groundwater use (10.26 BCM), there would be decline in the gross cropped area for the state as a whole, which was measured as only -1.41% with respect to existing GCA. When the groundwater use is increased to 12.83 BCM, then GCA would be pushed up by 15.73% as compared to the existing GCA of the state.

It is further observed that at existing groundwater

Table 3 Gain due to optimal crop model over two different GW use scenarios in Bihar

Optimal scenario	Change in GCA (%)	Existing revenue ('00 crores)	Optimal net returns ('00 crores)	Change in farmer's revenue ('00 crores) (Optimal-Existing $_{MP}$)	Gain to society ('00 crores)	Net gain ('00 crores)
Groundwater use at existing scenario (10.26 BCM)						
Market price	-1.41	122.15	131.72	9.57	0	9.57
Economic price	-1.41	96.84	106.16	-15.99	25.31	9.32
NRV	-1.41	91.44	101.43	-20.72	19.91	-0.81
Groundwater use increased by 25% of existing GW use (12.83 BCM)						
Market price	15.73	122.15	147.09	24.94	0.00	24.94
Economic price	15.73	96.84	116.85	-5.30	30.23	24.94
NRV	15.73	91.44	110.91	-11.24	24.83	13.60

scenario (10.26 BCM), optimal net returns are calculated as 131.72, 106.16 and 101.43 hundred crores at market price (MP), economic price (EP) and natural resource valuation price (NRV), respectively. Further, the gain to the society was estimated to be 25.31 and 19.91 hundred crores at EP and NRV. Thus, ultimate net gains to the cultivators are estimated to be 9.57, 9.32 and -0.81 hundred crores at three business scenarios. The change in farmer's revenue was found positive only at MP, i.e. 9.57 hundred crores. However, this positive change is at the cost which is paid by the society in terms of cost on subsidy on fertilizers, seeds and diesel etc.

In case of increased groundwater scenario at 12.83 BCM, the optimal net returns are worked out 147.09, 116.85 and 110.91 hundred crores at MP, EP and NRV, respectively and further, gain to the society would be obtained 30.23 and 24.83 hundred crores at EP and NRV, respectively. Finally, the cultivator's net gain has been assessed 24.94, 24.94 and 13.60 hundred crores at MP, EP and NRV, respectively. Thus, the gains are positive in all the three models of business as usual. These gains can only be obtained by pushing up the groundwater development as well as providing appropriate and cheap irrigation devices to the farming community of the state.

Conclusion

It may be summarized from the foregoing discussion that from optimum crop plan at existing groundwater use (10.26 BCM) for the state as a whole, it was observed that some crops such as paddy, wheat, ragi, sunflower and jute consisting in the model tend to decline its area at all three considered prices. Further, the gross cropped area under crops in optimum plan (existing GW use) also got reduced by -1.41% in comparison to existing GCA. The earning of the profit could be estimated 101.10 hundred crores. But, on the other hand, when the ground water use is increased by 25% (12.83 BCM), the gross cropped area would be obviously pushed up by 15.73% with respect to existing GCA of the state. Not only this, the almost all crops included in the optimum model tended to increase its area and thus, the earning of profit would be 110.91 hundred crores which is nearly 9 percent more than the existing optimal crop plan.

At the existing groundwater use scenario, the net gain to cultivators were found to be positive only at market price and economic price, whereas it was obtained positive at all the three models of business as usual under increased GW use. Thus, it may be inferred that in the state, if the water development is raised to 55% from the existing level of water development of only 44%, the adoption of optimum crop plan (at the new height of water development) would certainly raise the income of farming community. The adoption of model may further be accelerated, if the cheap source of irrigation devices such as subsidized electric operated pumping sets and solar operated irrigation devices are made available to the farmers. The adoption of the said model would obviously raise the income of the cultivators on the one hand and also augment the national exchequer on the other.

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REFERENCES

Bharati R C, Singh K M, Chandra N and Singh A K. 2014. Economic condition of eastern region of India-A statistical evaluation. *Journal of Agri Search* **1**(3): 173–9.

Dahiphale, Pravin, Singh P K, Mahesh Kothari and Kishore Gharde. 2015.Optimal cropping pattern for Jaisamand command of Udaipur district in Rajasthan, India. *Research Journal of Recent Sciences* **4**(ISC-2014): 1–7.

GOI. 2011. Central Ground Water Board, Ministry of Water Resources, Government of India, New Delhi, available at: http://cgwb.gov.in/

IIPR. 2003. Pulses in new perspective. (*In*) *Proceedings of the National Symposium on Crop Diversification and Natural Resource Management,* Indian Institute of Pulses Research, Kanpur, pp 20–2.

Peoples M B, Ladha J K and Herridge D F. 1995. Enhancing legume N2 fixation through plant and soil management. *Developments in Plant and Soil Sciences* **174**: 83–101.

Raghava Rani Y and Tirupathi Rao P. 2012. Multi-objective crop planning for optimal benefits. *IJERA* **2**(5): 279–87.

Raju S S, Ramesh Chand, Srivastava S K, Kaur Amrit Pal, Singh Jaspal, Jain Rajni, Kingsly Immaneulraj and Kaur Parminder. 2015. Comparing performance of various crops in Punjab, based on market and economic prices and natural resource accounting. *Agricultural Economics Research Review* **28** (Conference issue).

Singh K M, Dixit R S and Singh D K. 1990. District level agricultural planning for Almora district, Uttar Pradesh-A multi-level, multi-objective programming approach. *Economic Affairs* **35** (1): 48–56.

Singh R K P, Singh K M and Kumar, Abhay. 2015. Agricultural development in Bihar: Some empirical evidences. *Agricultural Situation in India* **LXX** (12): 5–13.

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