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Doubling farmers' income in Delhi state: An introspection

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ABSTRACT

The state of Delhi is fast growing in terms of urbanisation which is putting a lot of pressure on the agriculture sector of the state. The state is impacted due to fast declining area under agriculture and large urban population to meet the food requirement. In the past the policies were framed to enhance production but of late it is increase in income of the farmers that has become of prime importance. In this background the study was taken up to analyse the problems and prospects of agricultural sector of Delhi state and to suggest strategies for doubling the farmers' income. Intensive primary survey and focus group discussions of 180 farm households were conducted for the study by using pre-tested questionnaire. A linear programming model was used for assessing the optimal crop enterprise combination. The study revealed that the reorientation of crop enterprise towards vegetables, fruits and flowers in combination with allied enterprises like apiary and dairy would enhance the farmers income up to 53% to 198% under various categories of farmers. Further, the availability of loans up to 40% of existing capital would augment the farm income to the tune of 110% to 251%.The study suggest that agriculture be declared as an enterprise which will help farmers to get benefit of government schemes. There exists huge scope for post-harvest processing and value addition of vegetables, wheat, rice, etc. The farmers need to be organised like FPO, SHGs, etc., so that their bargaining power is increased and farmers are able to realise better price for their farm products.

Key words : Agriculture in Delhi, Doubling farmers income, Linear programming

Agricultural strategy in the country during the planned development era has been to ensure food security and farmers have responded to the nation's needs well and adopted Green Revolution technology (Satyasai and Mehrotra 2016). The strategy did not explicitly recognise the need to raise farmers' income and did not mention any direct measure to promote farmers' welfare. The low and highly fluctuating farm income is causing detrimental effect on the interest in farming and farm investments, and is also forcing more and more cultivators, particularly younger age group, to leave farming. This can cause serious adverse effect on the future of agriculture in the country (Chand, 2017). The strategies suggested by various authors included expanding irrigation, diversification to high-value crops/enterprises, better price realisation, improving terms of trade for agriculture, technology up-gradation, non-farm activities, bolstering livestock sector , tapping solar power on farmers' fields, and so on (Chand 2016; Gulati and Saini 2016 and Satyasai and Mehrotra 2016). Delhi state has 167.87 lakh population during 2011 which has grown from 138.51 lakh population of 2001. The large majority of this population is urban comprising 163.69 lakh and only 4.19 lakh is rural population. There is tremendous pressure on this small population to feed the growing urban population and also to meet their own aspirations. The present study was therefore undertaken to understand the status of agriculture in Delhi, the constraints faced by the farmers and to suggest strategies to improve the condition of agriculture in the state.

MATERIALS AND METHODS

The secondary data was compiled on various economic aspects like gross state domestic product, area irrigated, production and yield of food grains, land use pattern, cattle population, livestock production, from the various published sources of Government of Delhi. The primary data was collected from the three blocks of Delhi state, i.e. Najafgarh (villages- Mitraon and Nalimpur), Alipur (villages- Tatesar and Tiggipur), Kanjhawala (villages-Garhirandhala and Junti) from 180 sample households on aspects like socio-

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economic profile of sample farmers, the inputs and returns from agriculture and allied enterprises and constraints faced by the farmers and suggestions to ameliorate the same.

Alinear programming approach was used for assessment of optimal crop enterprise combination that would maximise the income of the farmers. The model is specified as;

Objective function:

$$\text{Maximise } \sum_i^m X_i \leq LH \quad (1)$$

Subject to

$$\sum_i^n X_i \leq C_{lr} \quad (2)$$

$$\sum_i^m X_j \leq C_{lk} \quad (3)$$

$$\sum_i^m X_j \leq C_{lk} \quad (4)$$

$$\sum_i^m X_j L_j \leq C_{lk} \quad (5)$$

$$\sum_i^n X_i S_j \leq C_{sr} \quad (6)$$

$$\sum_i^m X_i S_j \leq C_{sk} \quad (7)$$

$$\sum_i^n X_i F_j \leq C_{fr} \quad (8)$$

$$\sum_i^n X_i M_i \leq C_{mr} \quad (9)$$

$$\sum_i^n X_i M_i \leq C_{mr} \quad (10)$$

$$\sum_i^m X_j Mj \leq C_{mk} \quad (11)$$

$$\sum_i^n X_i PPC_i \leq C_{ppcr} \quad (12)$$

$$\sum_i^n X_i IRR_i \leq C_{irrr} \quad (13)$$

$$\sum_i^n X_i IRR_i \leq C_{irrr} \quad (14)$$

$$\sum_j^m X_j IRR_j \leq C_{irrk} \quad (15)$$

$$\sum_i^n X_i MKT_i \leq C_{mktr} \quad (16)$$

$$\sum_j^m X_j MKT \leq C_{mktk} \quad (17)$$

$$X_1 \leq 0.5LH \quad (18)$$

$$X_2 + X_3 + X_4 \geq .25LH \quad (19)$$

$$X_5 + X_6 \leq .25LH \quad (20)$$

$$X_7 + X_8 \geq .35LH \quad (21)$$

$$X_9 + X_{10} + X_{15} \geq .25LH \quad (22)$$

$$X_{11} + X_{12} + X_{13} + X_{14} \geq .20LH \quad (23)$$

$$X_{16} + X_{17} \leq .20LH \quad (24)$$

$$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8 + X_9 + X_{10} + X_{11} + X_{12} + X_{13} + X_{14} + X_{15} + X_{16} + X_{17} \geq 0 \quad (25)$$

For large farms the equation no 19, 20, 21, 22, 23 are modified as

$$X_2 + X_3 + X_4 \geq .20LH \quad (26)$$

$$X_5 + X_6 \leq .30LH \quad (27)$$

$$X_7 + X_8 \geq .30LH \quad (28)$$

$$X9 + X15 \geq .20LH \quad (29)$$

$$X_{11} + X12 \geq .15LH \quad (30)$$

$$X_{10} + X_{13} + X_{14} \geq .15LH \quad (31)$$

where, 'i' refers to kharif crops and 'j' refers to *rabi* crops, LH is land holding in ha, L is labour cost in ₹, S is Seed cost in ₹, F is fertiliser used in ₹, M is manures applied in ₹, PPC is plant protection chemicals used in ₹, IRR is irrigation applied in ₹, Mkt is marketing cost in ₹, 'r' refers to rabi season, 'K' refers to kharif season, Y is income from crop enterprises, C is capital used by the farmers for purchase of various inputs (₹).

The scenario of optimal plan was estimated separately for small, medium and large farms for various levels of capital relaxation situations ranging from 20% to 40% higher than that of the prevailing resource endowment. The area under the crop groups were constrained considering the broader objectives of the farmers for having diversified crop portfolio for the purpose of realisation of continuous income, minimisation of price and demand risk (Table 1).

RESULTS AND DISCUSSION

Status of agriculture in Delhi

The rural area under the Delhi state has shrunk from 1157.5 sq km in 1961 to 369.4 sq km by 2011 recording a declining growth rate of (-) 2.17% per annum. Thus in recent years only 25% of the total area remains under the rural class of land (Government of India, Various issues). The fast pace of urbanisation has reduced the number of villages in Delhi from 300 in 1961 to 165 in 2001 and 112 in 2011. The fall in area under rural area has left its impression in the form of very meagre contribution of agriculture and allied sectors to total gross state domestic product of Delhi state of 1.9% in 2004 which has further fallen to 0.7% by year 2014-15 (Government of Delhi 2017). The compound annual growth rate of GSDP from fishing sector has recorded a decline of (-)3.09 while that from agriculture and livestock has recorded a growth rate of 4.97 and from forestry and logging recorded a modest growth of 1.38% during the period 2004-15. The net sown area in Delhi state has fallen from 58551 ha in 1980-81 to 23150 ha in 2016-17 recording a growth rate of (-)3.12% per annum (Government of Delhi 2017). Similarly the total cropped area has reduced from 87599 ha in 1980-81 to 34750 ha in 2016-17 recoding a growth rate of (-)3.19% per annum. The cropping intensity has however remained more or less same at 150%. The major source of irrigation in Delhi is wells accounting for about 90% of total irrigated area. The area under irrigation by canals has remained constant however a drastic reduction in area under wells is observed which has decreased from 42306 ha in 1995-96 to 19561 ha in 2015-16 recording a decline of (-)3.73% per annum (Government of Delhi 2016). This is having an adverse implication on irrigated area and

Table 1 The allocation of land under different crop enterprise combinations assumed for the purpose of modelling for determination of optimal crop enterprises

Crop	Small farms	Medium farms	Large farms
Rabi season			
Wheat and barley	More than or equal to 35 % of land holding	More than or equal to 35 % of land holding	More than or equal to 30 % of land holding
Gram, mustard and potato	More than or equal to 25 % of land holding	More than or equal to 25 % of land holding	
Gram and mustard			More than or equal to 20 % of land holding
Methi, dhania, raddish, cabbage	More than or equal to 20 % of land holding	More than or equal to 20 % of land holding	
Methi and Dhania			More than or equal to 15 % of land holding
Raddish, cabbage and potato			More than or equal to 15 % of land holding
Baby corn and strawberry	Less than or equal to 20 % of land holding	Less than or equal to 20 % of land holding	Less than or equal to 20 % of land holding
Kharif season			
Paddy	More than or equal to 50 % of land holding	More than or equal to 50 % of land holding	More than or equal to 50 % of land holding
Bajra, maize and jowar	More than or equal to 25 % of land holding	More than or equal to 25 % of land holding	More than or equal to 20 % of land holding
Baby corn and marigold	Less than or equal to 25 % of land holding	Less than or equal to 25 % of land holding	Less than or equal to 30 % of land holding

gross irrigated area which has reduced to 21786 ha and 29429 ha respectively. The major crops cultivated in the state are wheat, barley, bajra, maize, jowar, paddy, gram, potato and sugarcane (Government of Delhi 2017). The area under wheat crop has decreased from 30.43 thousand ha in 1995-96 to 19.37 thousand ha in 2015-16. However, the total productivity of wheat has increased from 3.58 t/ha to 4.42 t/ha during similar periods (Table 2).While, the area under paddy crop has remained constant during the periods of 1995-96 to 2015-16, but the productivity of paddy also followed same trend as that of productivity of wheat. This rise in productivity has enabled the state to maintain the production levels of wheat to about 86 thousand tonnes while that of paddy has recorded an increase in production to 26 thousand tonnes by 2015-16. The total livestock population in the Delhi state has recorded a marginal growth of 0.20% per annum which is mainly due to growth in population of goats (1.37%), horses and ponies (3.03% and pigs (4.98%) during the period 1997 to 2012 (Government of Delhi 2016). The cattle, buffaloes and sheep population has recorded a decline at the rate of (-)0.32 and (-) 1.02 and (-) 13.13% per annum respectively. The number of poultry birds has seen a sharp decline at the rate of (-) 19.54% per annum during the period 1997-2012. The fall in livestock population has implication on milk production stagnating at 280 tonnes. The meat production having increased from 25383 tonnes to 53647 tonnes during the period 1996-97 to 2014-15 (Government of Delhi 2016). Given this very depressive state of agriculture sector it is important to look at the ways and means to improve the income of the farmers dependent on agriculture sector in the Delhi state.

The major crops and other enterprises followed by the sample famers of the Delhi state paddy, wheat, mustard, dairy, vegetables, bee keeping and fishery. The income realised from each enterprise was computed and it was observed that the wheat, paddy and mustard are the principal crops grown by majority of the farmers and gave a net return of ₹ 24476, ₹ 29809 and ₹ 31118 per ha respectively (Table 3). Some of the enterprising farmers did take up other crops like raddish, methi, cabbage and dhania which gave a net returns of ₹ 15182, ₹ 24306, ₹ 24448, and ₹ 36384 per ha respectively. A few more farmers who were highly enterprising took up strawberry, baby corn and marigold cultivation which gave a net return of ₹ 352619, ₹ 46017 and ₹ 117902. The allied enterprises adopted by the farmers were bee keeping and dairy which gave a return of ₹ 2200750 and ₹ 700000 (Table 4 & 5). However, the large scale adoption of these innovative and high income enterprise were limited due to various constraining factors which needs to be understood in depth and policies need to be adopted to overcome the same. With the existing capital base the farmers could enhance their income by restructuring the crop enterprises. This was achieved with the help of linear programming approach. The optimal crop combinations evolved through the use of LP model is presented inAppendix Tables 6 to 7. It is observed that the small farmers could enhance their income from ₹ 21752 to ₹ 64829 amounting to 198 % increase. Similarly the medium

Table 2 Area, production and yield of food grains in Delhi during 1995-96 to 2015-16

Year	(Area '000 ha, Production in '000 t, yield in t/ha)								
	Wheat	Barley	Bajra	Maize	Jowar	Paddy	Gram	Potato	Sugarcane
Area									
1995-96	30.43		3.10		8.67	6.18			
2000-01	27.81		3.09		8.63	6.04			
2005-06	18.29		1.68		8.86	7.49		2.91	
2010-11	20.09	0.07	1.54	0.40	3.30	6.73	0.05	1.00	0.003
2015-16	19.37	0.06	1.51	0.04	3.13	6.04	0.02	0.46	
Production									
1995-96	84.9		5.7		3.9	15.5			
2000-01	97.9		4.6		8.2	17.1			
2005-06	79.4		3.1		7.8	31.6		33.2	
2010-11	87.4	0.19	2.9	0.88	3.2	28.6	0.07	15.9	0.23
2015-16	85.6	0.18	3.8	0.18	3.0	25.9	0.05	9.7	
Yield									
1995-96	2.79		1.84		0.45	2.51			
2000-01	3.52		1.49		0.95	2.83			
2005-06	4.34	2.61	1.85	1.8	0.88	4.22	1.43	11.42	75.0
2010-11	4.35	2.8	1.88	2.2	0.97	4.25	1.45	15.89	75.24
2015-16	4.42	2.92	2.51	5.1	0.96	4.29	2.1	21.27	

Source: Development Department, Govt. of National Capital Territory of Delhi; Delhi Statistical Hand Book 2016, DES, GNCTD

farms were able to gain increase in income by 81% and large farmers by 53 % over the existing income obtainable from the existing crop combinations. Considering the fact that the farmers are able to access loans from banks/RRBs or cooperatives, which they use for purchase of good quality seeds, fertilizers, irrigation and other inputs enables them to further restructure crop combination towards resource intensive enterprises. The optimal crop combination estimated using LP under the capital relaxed condition is presented in Table 5 to Table 7. It is observed that the small

Table 3 Cost and returns from prevailing crop enterprise (₹/ha)

Crop	Total variable cost	Total fixed cost	Total cost	Gross income	Net income	Benefit cost ratio
Mustard (sag)	29555	17327	46882	78000	31118	1.66
Bajra	29163	17308	46470	62750	16280	1.35
Paddy	26776	17415	44191	74000	29809	1.67
Jowar	22306	17043	39349	42500	3151	1.08
Maize	31625	17363	48988	76500	27512	1.56
Barley	23739	17323	41063	52560	11497	1.28
Gram	27097	17487	44584	77700	33116	1.74
Wheat	29395	17611	47006	71482	24476	1.52
Baby corn	38620	17363	55983	102000	46017	1.82
Methi	33651	17043	50694	75000	24306	1.48
Dhania	26573	17043	43616	80000	36384	1.83
Radish	39776	17043	56818	72000	15182	1.27
Cabbage	42509	17043	59552	84000	24448	1.41
Marigold	64487	17611	82098	200000	117902	2.44
Stawberry	229770	17611	247381	600000	352619	2.43
Potato	67252	17043	84294	101500	17206	1.20

Table 4 Cost and returns from honey enterprise

Particulars	Quantity	Amount (₹)
Cost		
Box	750 No.	142500
Sugar/ Gur		10000
Medicine		10000
Transport cost		25000
Labour	18 No	2160000
Charge for keeping box in others field		15000
FSSAI certification		500
Sub-total		2363000
Returns		
Honey wax	37.5 Kg	37500
Honey	33750 Kg	2700000
Pollen	2250 Kg	1687500
Polish	1125 Kg	393750
Gross return (₹)		4818750
Net return (₹)		2200750
B:C ratio		2.04:1

Table 5 Cost and returns from dairy enterprise

Particulars	Rate	Quantity	Amount (₹)
Apportioned cost of cow (life 10 Years)	₹ 80000	20No	160000
Cattle shed (life 15 years)		1	33333
Packing machine (life 5 years)		1	39000
Cattle feed	₹ 20/ kg	36500 kg	730000
Bhusa	₹ 5 per kg	43800kg	219000
Green fodder	₹ 10 per kg	36500kg	365000
Labour		6 No	54000
Crate	₹ 250 each	20 No	5000
Feed chopper (life 5 years)		1 No	5000
Motor (life 5 years)		1 No.	2633
Veterinary doctor services		2 times per week	7000
Medicine	₹ 500 per cattle		10000
Semen	₹ 1200/ semen	10 No	12000
Water tanker	₹ 500 per trip	122 days	60833
Total cost			1702800
Calf (10 No.)			100000
Milk yield		67200 litre	2284800
Cow dung	₹ 400 per trolly	20 trolly	8000
Gross income			2402800
Net income			700000
B:C ratio			1.41:1

farmers are able to enhance their income upto ₹ 76256 leading to 256% increase. Similarly the medium and large farmers are able to enhance their income by 133% and 110 % respectively. Thus, it is revealed that the optimal plan under the capital relaxed situation itself is enabling the farmers to meet the target of doubling the farmers' income through adoption newer crop enterprises already being practiced by many innovative farmers of the region. The optimal agriculture and allied activities plan evolved through modelling enables diversification of enterprises which will have a bearing on risk reduction and enables the farmers to absorb price and demand shocks. The farmers are presently focusing on foodgrain crops leading to realisation of almost 99 % income from the crop enterprises (Table 6). The optimal plan suggest incorporation of vegetables, fruits, flowers and allied activities. The small farmers are able to realise 54% of their total income under the optimal plan from dairy enterprise and is followed by vegetables (9.4 %), flowers (4.9 %) and fruits (3.0 %). The medium farms on the other hand are able to realise 24 % of income from dairy under the optimal plan and is followed by vegetables (15.4 %), flowers (8.1 %), oilseeds (7.3%) and from fruits (5.1 %). Thus the diversified income portfolio of the farms has very beneficial effect in reducing the dependence of farmers on food crops. The farmer is able to realise higher returns from adoption of dairy, apiary, flower and fruit production.

Constraints faced by farmers of Delhi

Delhi stands on the west bank of Yamuna River and is spread over an area of 1.47 lakh ha with a net sown area of 23150 ha. Tube wells and wells are the major source of irrigation. Major crops grown are paddy, wheat, bajra, potato, vegetables, dairy, fishery and bee keeping etc. Livestock plays significantly in the livelihood of the famers major livestock reared are buffaloes, cattles, pigs, goats etc. Major canal water source has been blocked which makes water table rising up to as high as 2 to 3 ft. In such regions the vegetable crops cannot be grown successfully. Further the soil is highly saline due to which wheat and paddy other crops cannot be raised. The farmers felt that Delhi is not declared as an agriculture state therefore many of the subsidies and benefits of various government schemes meant for agriculture sector are not available to Delhi farmers. The farmers also complained that they cannot do any kind of construction activity like farm shed, poultry shed, dairy shed, etc., on their farms making it difficult for them to adopt the allied sector enterprises. The major constraints of the farmers are summarised below:

- Agriculture is not recognized as an enterprise in Delhi state. Therefore Government schemes are not available to the Delhi farmers and creation of infrastructure on agricultural lands is not permitted and invites penalty under Act 81.
- Farmers cannot invest in putting up tube wells, which is adversely affecting the irrigation development
- Lack of processing and value addition opportunities. Farmers are also not setting up processing infrastructure for cereals, vegetables and dairy products
- Farmers are getting low price of vegetables
- Problem of wild animals (Nilgai) and other wild animals
- Availability of spurious seeds, insecticide and pesticide and lack of availability of seeds of Pusa-IARI & other good quality at reasonable price
- Subsidies are not available to farmers for tractors and other agricultural machinery therefore it cannot be purchased in Delhi. Purchase of tractors in Delhi invites commercial rate of interest and electricity is provided at industrial rates
- Subsidy provided by State Government does not reach tenant farmers.
- KCC scheme is not available to Delhi farmers and if farmers avails crop loan, then limit is one lakh.
- The crop insurance scheme facility is not available to Delhi farmers
- The soils of agricultural fields in South-West district of Delhi are saline in certain pockets resulting in cultivation of only rice and wheat crops and prevents

Table 6 Income from various combination of crop and allied enterprises under the existing capital and with availability of additional capital

Crop and allied enterprises	Small farms			Medium			Large		
	Existing crop enterprises	Optimal plan	Optimal plan with 40% additional capital	Existing crop enterprises	Optimal plan	Optimal plan with 40% additional capital	Existing crop enterprises	Optimal plan	Optimal plan with 40% additional capital
Cereals	21530 (99)	14756 (22.8)	14109 (18.5)	159245 (99.0)	109049 (37.5)	104177 (27.8)	551315 (99.0)	361532 42.5)	347788 (29.7)
Pulses	33 (0.2)	984 (1.5)	1547 (2.0)	132 (0.1)	7339 (2.5)	11630 (3.1)	497 (0.1)	0	
oilseeds		2888 (4.5)	2359 (3.1)		21288 (7.3)	17255 (4.6)	0	78000 (9.2)	78000 (6.7)
Vegetables	189 (0.9)	6078 (9.4)	7514 (9.9)	1428 (0.9)	44856 (15.4)	55534 (14.8)	4955 (0.9)	172132 (20.2)	209526 (17.9)
Fruits		1975 (3.0)	4302 (5.6)		14775 (5.1)	31983 (8.5)	0	0	72886 (6.2)
Flowers		3148 (4.9)	11425 (15.0)		23439 (8.1)	84536 (22.5)	0	81847 (9.6)	303302 (25.9)
Dairy		35000 (54.0)	35000 (45.9)		70000 (24.1)	70000 (18.7)	0	140000 (16.4)	140000 (16.4)
Honey bee							0	18027 (2.1)	18027 (2.1)
Total net income	21752	64829 (198%)*	76256 (251%)*	160806	290476 (81%)*	375115 (133%)*	556767	851538 (53 %)*	1169529 (110%)*

Figures in parenthesis are per cent to the total; * refers to per cent to the existing plan total

Table 7 Optimal farm plan for small farmers – crop and allied enterprises

Crop	Existing crop enterprise combination							
	Area (ha)	Net income (₹)	Existing capital		20% additional capital		40% additional capital	
			Area (ha)	Net income (₹)	Area (ha)	Net income (₹)	Area (ha)	Net income (₹)
Kharif								
Paddy	0.276	8227	0.245	7303	0.245	7303	0.245	7303
Bajra	0.069	1123	0.0267	435	0	0	0	0
Maize	0.002	55	0.1025	2820	0.1225	3370	0.0912	2509
Jowar	0.143	451	0	0	0	0	0.0313	99
Babycorn	0	0	0.0036	166	0.0031	143	0	0
Marigold	0	0	0.0267	3148	0.0614	7239	0.0969	11425
Rabi								0
Wheat	0.476	11651	0.1715	4198	0.1715	4198	0.1715	4198
Barely	0.002	23	0	0	0	0	0	0
Gram	0.001	33	0.0297	984	0.0523	1732	0.0467	1547
Potato	0.011	189	0	0	0	0	0	0
Dhania	0	0	0.1501	5461	0.1204	4381	0.098	3566
Mustard			0.0928	2888	0.0702	2184	0.0758	2359
Baby corn	0	0	0.0098	451	0.0676	3111	0.0858	3948
Strawberry	0	0	0.0056	1975	0.008	2821	0.0122	4302
Total net income (₹)	0.98	21752	0.864	29827 (37%)	0.922	36482 (68%)	0.9544	41254 (90%)
Dairy enterprise			Jersey (1)	35000	Jersey (1)	35000	Jersey (1)	35000
Total net income (Agri and Allied)				64827 (198%)		71482 (229%)		76254 (251%)

Figures in brackets are percent to the total income from existing crop enterprises

Table 8 Optimal farm plan for medium farmers – crop and allied enterprises

Crop	Existing crop enterprise combination							
	Area (ha)	Net income (₹)	Existing capital		20% additional capital		40% additional capital	
			Area (ha)	Net income (₹)	Area (ha)	Net income (₹)	Area (ha)	Net income (₹)
Kharif								
Paddy	2.042	60870	1.8115	53999	1.8115	53999	1.8115	53999
Bajra	0.512	8335	0.2017	3284	0	0	0	0
Maize	0.012	330	0.7535	20730	0.9058	24921	0.6686	18395
Jowar	1.057	3331	0	0	0	0	0.2371	747
Babycorn	0	0	0.025	1150	0.0204	939	0	0
Marigold	0	0	0.1988	23439	0.455	53645	0.717	84536
Rabi								
Wheat	3.524	86253	1.268	31036	1.268	31036	1.268	31036
Barely	0.011	126	0	0	0	0	0	0
Gram	0.004	132	0.2216	7339	0.3883	12859	0.3512	11630
Potato	0.083	1428	0	0	0	0	0	0
Dhania	0	0	1.1131	40499	0.8932	32498	0.7246	26364
Mustard			0.6841	21288	0.5175	16104	0.5545	17255
Baby corn	0	0	0.0697	3207	0.4961	22829	0.6339	29170
Strawberry	0	0	0.0419	14775	0.0599	21122	0.0907	31983
Total net income (₹)	7.245	160806	6.3889	220746 (37%)	6.8157	269951 (68%)	7.0571	305114 (90%)
Dairy enterprise		70000	Jersey (2)	70000	Jersey (2)	70000	Jersey (2)	70000
Total net income (Agri and Allied)		230806 (44)		290746 (81)		339951 (111)		375114 (133)

Figures in brackets are percent to the total income from existing crop enterprise.

diversification to other crops
- The cultivable lands in few pockets of Delhi are having very high water table restricting the choice of crops in South-West district of Delhi
- The farmers lack knowledge of mushroom cultivation
- Lack of extension support by public agencies, Losses due to poor sanitation and pest and disease attack (mushroom)
- Lack of access to export market for high value commodities
- Soil health card scheme is not operating in right spirit, takes lot of time in delivery of test report
- Most of the land is owned by absentee landlords and tenant farmers are forced to take on lease
- Poor management and infestation of diseases affects the productivity and profitability from dairy
- Retail procurement is of only good quality vegetables and rejection rate is high, procurement of quantity is very low.
- It is difficult to get FSSAI certification and involves high transaction cost
- Cooperative societies were created by the farmers but became non-functional due to infighting
- Farmers lack knowledge about FPOs, its functioning and its advantages
- Farmers have discontinued fruit crops due to growing problem of theft and uncertainty of government policies.
- Contract farming is mostly on verbal agreements.
- Land leasing is informal and therefore, benefit of Government schemes are not reaching to the farmers.

Conclusions and way forward

The Delhi state is facing a situation where the rural area is shrinking at a fast pace and the area under wells is falling drastically. This has resulted in reduction in total cropped area from 87599 ha in 1980-81 to 34750 ha in 2016-17. The farmers are still rooted to foodgrain production with little of diversification towards the horticulture and other allied enterprises. On one hand there is a huge demand of horticultural crops from Delhi state on the other hand the farmers are practicing the subsistence crops. The reason for this paradoxical situation is the non-recognition of agriculture as an enterprise in Delhi. This is having an impact on implementation of policies and programmes related to agriculture. The farmers are not able to receive subsidies nor are they in a position to do capital investment in terms of construction of farm buildings, sinking of tubewells, buying of tractors, etc. Certain pockets of Delhi

Table 9 Optimal farm plan for large farmers – crop and allied enterprises

Crop	Existing crop enterprise combination		Proposed crop enterprise combination under different capital availability scenarios					
	Area (ha)	Net income (₹)	Existing capital		20% additional capital		40% additional capital	
			Area (ha)	Net income (₹)	Area (ha)	Net income (₹)	Area (ha)	Net income (₹)
Kharif								
Paddy	7.076	210929	6.2665	186799	6.2665	186799	6.2665	186799
Bajra	1.744	28392	0.6468	10530	0	0	0	0
Maize	0.041	1128	2.6234	72176	2.7451	75524	2.5066	68962
Jowar	3.663	11542	0	0	0	0	0	0
Babycorn	0	0	0.0893	4109	0.2945	13552	0.1309	6024
Marigold	0	0	0.6942	81847	1.6174	190694	2.5725	303302
Rabi								*0*
Wheat	12.211	298876	3.7599	92027	3.7599	92027	3.7599	92027
Barely	0.039	448	0	0	0	0	0	0
Gram	0.015	497	0	0	0	0	0	0
Potato	0.288	4955	0	0	0	0	0	0
Dhania	0	0	3.0944	112587	2.5711	93547	1.8999	69126
Raddish	0		1.6296	24741	1.88	28542	1.88	28542
Cabbage	0		0.2504	6122	0	0	0	0
Mustard	0		2.5066	78000	2.5066	78000	2.5066	78000
Baby corn	0	0	0.534	24573	1.7294	79582	2.2999	105834
Strawberry	0	0	0	0	0.106	37378	0.2067	72886
Total net income (₹)	25.077	556768	22.0951	693510 (25%)	23.4765	875645 (57%)	24.03	1011503 (82%)
Proposed allied enterprises								
Dairy enterprise	Jersey (4)	140000	Jersey (4)	140000	Jersey (4)	140000	Jersey (4)	140000
Honeybee	Box (10 No)	29343	Box (10 No)	29343	Box (10 No)	29343	Box (10 No)	29343
Total net income (₹) (Agri and Allied)		726111 (30.42%)		862853 (54.98%)		1033672 (87.69%)		1169530 (110.05%)

Figures in brackets are percent to the total income from existing crop enterprises.

state have poor soil where the research organisations can provide necessary technical guidance for soil reclamation and improving the fertility of the soil. There is an urgent need to declare agriculture as an enterprise for getting subsidized loan from banks and recognition of farmer status. There exists huge scope for productivity improvement through use of certified seeds and input cost minimization. The problem of Neelgai and dry milch animals can be solved through the help of Animal husbandry department. The farms need to be fenced so as to prevent the wild animals from damaging the field crops. There is a need for provision of subsidies for the purpose of fencing of the farm land. The processing and value addition of vegetables, wheat, rice and dairy products would enhance the income of the farmers. There is a need to promote the setting up of custom hiring centres. Suitable marketing strategies very much needed to increase the farmers share in consumer rupees through institution like farmers producer organization (FPO), or schemes such as Bhavantar of MP or Kalia of Odisha. The farmers can double their income if they merely follow the optimal farm plan suggested through the use of LP model. The provision of credit to the farmers at a lower rate of interest is another factor which could boost the income of the farmers through adoption of suggested crop and allied enterprises. It is recommended that the farmers shift their focus from food grains to horticulture and livestock enterprises.

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