International Journal of Multidisciplinary Education and Research
ISSN: 2455-4588; Impact Factor: RJIF 5.12
Received: 29-04-2020; Accepted: 19-05-2020; Published: 29-05-2020
www.educationjournal.in
Volume 5; Issue 3; 2020; Page No. 13-17

Population pressure and Agricultural change in Ganga-Gandak Doab

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Abstract
An attempt here has been made to portray the scenario of agricultural change under acute population pressure, accompanied with deriving the benefit of agro bio-diversity in the Ganga-Gandak doab i.e. almost coterminus with Saran district of Bihar.
The study region after Independence, particularly after 1961 has consistently registered unbridled growth of the population till 2001 with a cumulative increase of >150%. As a result, the overall density of population has gone up from >500 persons (1961) to >1400 persons (2011) km². The physiological density (persons per km² of the N.A.S.) of population has shown rather faster increase due to the shrinkage in the net cultivated land.
Endeavours afoot however, are visible to compensate the aforementioned loss through multiple cropping or say, by increase in the double and triple cropped land with the use of tractors and power-tillers. The crop-structure has also changed over this period. The cereals have shown remarkable increase in areal coverage while the inferior to very inferior millets and pulses have disappeared from the agricultural scene of the doab. As a result, the crop-association now is of lesser number of crops in comparison to its past strength.
The fact that population pressure has been reduced to a certain extent by the agricultural development during Green-revolution, is irrefutable. But there is no halt on the growth of population. So, the pressure is to continue in future as well. Hence, the agro-bio diversity available in the doab through the raising of crops in association with poultry, piggery, fishery, goatery and dairy needs to be rationally utilized.

Keywords: imbalance, maladjustment, expectation, ambition, observational relational, S.D., arithmetic, physiological, nutritional, diminishing return, diversification, index, volume and association

Introduction: Abiotic setting

The Ganga-Gandak doab coterminus with Saran district of Bihar from the north, south and east in an area of 2664.76 Km² extends from 25° 36´N latitude to 26°13´N latitude and from 84°24´E longitude to 85°15´E longitude. Its situation in which the Ganga river in its south receives the discharge of Gandak, Ghaghra and Son and makes the area highly sensitive from hydrographic point of view in respect of flood by rushing water back into the tributary (Mahi), imparts it an unique geographical personality in North Bihar plain. The doab traversed by 55m contour in the north-west and of 45m in the south-east where Ganga and Gandak make confluence at Sonepur, is the lowest section of the Gandak cone. It is here that the concavity in the ground-slope of the cone begins to come into experience, demarcated by Mahi river, south of which flood is frequent but, in the north, it is rare.

Concept

Population pressure denotes imbalance between resources of a community and the population living within its territory. In other words, it is a maladjustment between the two, giving rise to stress or say, a situation of pressure on the land (Tauber, 1970, Clarke, 1970, Browning, 1970) [10, 4, 1]. By any measure "a given piece of land can support only a given number of inhabitants" is an indicator whether there is pressure or no pressure on the land (Chandna, R.C. 2016) [3].

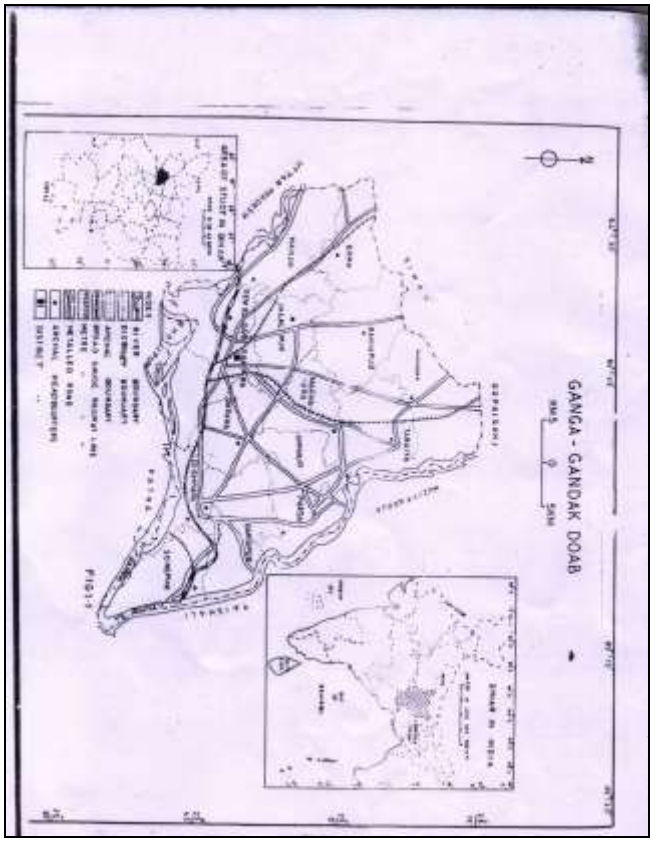

Fig 1

Becoming specific to the Ganga – Gandak doab, the anxiety is over the mounting of pressure expressed through the density of population from over 500 persons (1961) to over 1400 persons Km² (2011). The agricultural and non-agricultural land taken together; the per capita land hardly accounts for one hectare. If the present growth-rate of population continues, the concept of per capita land at least, will have no meaning in the doab.

The agricultural revolution or say, the "Green", "White" and "Blue" revolutions in the 2nd half of the 20th Century (in the post-drought period) has undoubtedly kept the economy in a position to have balance between the population and resource to a certain extent through a number of innovations, together called as the "agricultural change". Agricultural change begins with the increase in area sown more than once, meaning out an increase in the total cropped land and the introduction of inputs including irrigation i.e. the sin qua non in raising crops the world over. Among inputs, the biological includes seeds and chemical fertilizers while the mechanical means the increasing use of machines (tractors and power tillers) at the cost of traditional animate means (bullock) and the indigenous tools and appliances, being used since long in agricultural operations in the region (Sinha S. Bihari, 1986) [8].

Methodology

Since long and even today, methods adopted in supplicating the results of research are (i) Observational-descriptive and (ii) Observational – relational according to Zobler (1957) [12]. The latter of course is precise and scientific which brings objectivity in the research. But when operational measurement of the variables like expectation, ambition becomes impossible in quantitative terms, the former i.e. description on the basis of observation is left out for the researcher. Here in the present study, the population pressure in terms of geographical, physiological and nutritional density has been analysed, taking help from the observational-descriptive while the agricultural change has been shown by showing change in the crop-diversification and crop-combination, worked out with the help of standard deviation (d^2).

Population Pressure

The percentage decadal growth-rate of the population accelerating from one decade to another since 1951 to 2011, entailing into the swelling of density (Geographical and physiological) and latter resulting into the out-migration of adult males, making the sex-ratio deficient in males, are the principal pointers of population pressure in the Ganga-Gandak doab.

Table 1: Percentage Variation in the growth of population in Ganga – Gandak Doab.

Census Year	Population	Variation (%)
1951	125630	--
1961	1447279	15.20
1971	1709722	18.13
1981	2084322	21.91
1991	25622939	22.98
2001	3251474	26.86
2011	3951862	21.54

***Source*:** D.C.H., Saran district, (Old and New)

Table (01) given above shows that the growth during 1951-1961 was slower by comparison but it gained momentum in the next decade of 1961-71 (18.13 %) during which the invention of wonder-drugs and the import of wheat from the abroad led to a decline in the death rate while the birth-rate remained constant. The rising trend later rather became yet more spectacular to bring a vertical rise in the growth-curve of population. As a result, the doab which had a population of only 1,25,630 in 1951 became far more populous with a total population of 39,51,862 in 2011. The aforementioned trend is true of both, the rural and urban population. The urban growth during 1971-81 is over 75%. It may be assigned to the annexation of sub-urban area to Chapra, Siwan and Gopalganj towns of the Saran district (old). The population of towns therefore, all of a sudden was swollen in size.

Table 2: Ganga - Gandak Doab Decadal Percentage variation in the growth of rural and urban population

Decade	1951-61	1961-71	1971-81	1981-91	1991-2001
Percentage of growth (rural)	13.40	16.21	16.30	22.12	26.28
Percentage of growth (urban)	18.83	19.75	75.94	38.30	27.21

***Source*:** D.C.H., Saran district (Old and new)

The cumulative percentage growth since 1951 to 1981 i.e. after 30 years of the Independence and the next again after 30 years in 2011 is an eye-opener for all of us, particularly, for the policy-makers.

Table 3: Ganga – Gandak Doab Cumulative percentage growth of population

Census Year	Population	Cumulative percentage growth
1951	1256306	-------
1981	2084322	65.90
2011	3951862	89.59

***Source*:** Census Hand Book, Saran District, (Old and new)

The cumulative growth during 1981-2011 (89%) is far ahead of the cumulative growth (65%) during 1951-1981. This is indicative of the mounting of pressure on the land within shorter span of time by comparison. Here it is worth mentioning that the growth by any measure (rural, urban or overall) is of varying magnitude on the space. It has been by comparison faster in components (Chapra, Sonepur and Dighwara) where there are Urban service centres. Besides, the whole area to the north of Mahi river has registered faster population growth in the doab. That means peopling in the flood-free section of the doab has been more conspicuous than in the flood-prone section i.e. South of Mahi river.

The next pointer of population pressure is the increase in density (Arithmetic & physiological) of population, reported after each & every census for the region. The Arithmetic density i.e. persons per Km² of the geographical area, is contained in the table given below.

Table 4: Ganga – Gandak doab Arithmetic density of population

Census Year	1951	1961	1971	1981	1991	2001	2011
Persons Km²	471	543	641	782	962	1220	1483

***Source*:** D.C.H., Saran District (Old and new)

The Arithmetic density was of 471 persons per Km² in 1951. After 30 years it rose to 782 persons in 1981. It shows a sizeable enhancement in pressure on the land. In the next

30 years, during 1981-2011, the density further rose to 1483 persons Km². It is yet more spectacular and almost double of the density in 1981 and triple of the density in 1951

Table 5: Ganga – Gandak doab Population pressure (Density per Km²)

Census year	1921	1961	1981	2011
Arithmetic	471	543	792	483
Physiological	595	777	973	1680
Nutritional	311.19	582.32	628.94	601.52
Per capita land in hectare	0.22	0.12	0.09	0.06

***Source*:** District Gazetteer and D.C.H. of Saran District (Old and new).

The increase in population pressure has been vividly displayed by the Table- 05. The impact of the increase in overall density over the period under review (1921- 2011) is visible in the decline of per capita land from 0.22 hectare in 1921 to 0.09 hectare in 1981 and 0.06 hectare in 2011 as shown in the bottom of Table- 05 from the column 2nd to 5th. Agricultural and non-agricultural land taken together; the aforementioned area may be worked out to a maximum of less than one katha per-head. Even with the present agricultural technology which is available to the farmers, this is unviable and undependable. With the present rate of population growth, it will have to face further decline.

The increasing physiological density from 595 (1921) to 1680 (2011) persons per Km² of the net area sown, indicates rather acute pressure on the land because the cultivable land undergoes strain, firstly by occupancy for the hut and houses and secondly by swelling in the arithmetic density due to the unbridled increase in population. The physiological density as shown in the Table- 05 was 595 in 1921. Over the 40 years during 1921-1961, there had been an addition of 182 persons per Km² of the net cropped land. That means that there was an increase of 45 persons (approx) per decade. But only over 20 years (1961-81), nearly 200 persons have been accreted, meaning out an accretion of 100 persons per decade on the net cropped land. The next 30 years (1980-2011) are of the spectacular increase in physiological density. In this period 707 persons per Km² were added only over 30 years, accounting for an addition of over 200 persons per decade. It appears that the strain in the net cultivated land is gradually increasing in its magnitude due to the reasons alluded above. That means that there is no way out to resist decline in the geographical area of cultivation.

Out migration of Population

The out migration of population is also a significant indicator of the population pressure on land in the Ganga - Gandak Doab. The Ganga-Gandak doab in this respect has been famous since very long time. O' Malley (1908) as back as in the beginning of the 20 the century had remarked that "the Saran district promoting a prolific migration of population within and out the bounds of the State of Bihar, is an unique region in the country whose people evince rare readiness either permanent or temporary" (cited by Gupta, P.N., 1921). The male deficient sex-ratio over 80 years (1901-81), is also an authentic testimony of the emigration of mainly males from the doab.

Table 6: Ganga – Gandak doab Sex-Ratio, 1901-2001

Census Year	1901	1911	1921	1931	1941	1951	1961	1971	1981	1991	2001	Population
Females per 1000 of males	1119	1151	1066	1038	1082	1132	1148	1052	1019	963	965	Total
	1205	1157	1071	1044	1068	1110	1150	1061	1045	NA	NA	Rural
	1073	988	901	845	881	910	871	851	888	NA	NA	Urban

***Source*:** District Gazetteer and D.C.H. of Saran district (Old and new)

The female-deficiency in the last century has been for the first time reported in 1991. It may be an outcome of the development, leading to the generation of opportunities of job and employment in agriculture as well as in activities allied with the farming.

Agricultural Change

The agricultural change in the Ganga-Gandak doab as elsewhere in the Indo-Gangetic Plain began after the drought of 1966-67 with an inception of the tube-well irrigation and innovations in seed, fertilizer and agricultural appliances. Its first impact came on the extent of the gross-cropped land, leading gradually to a decline in the Nutritional density of population as shown back in Table-05. The population has undergone explosive increase over the period but the increase in Nutritional density i.e. number of persons per Km² of the total cropped land, is mild and moderate till date. Next, the agricultural change has been witnessed in the crop-structure in which cereals (rice, wheat and maizes) have gained pre-eminence while others (pulse, millet etc.) have either been relegated in the ranking or they have been fully dislodged from the agricultural scene. Bokla, Kulthi, Kodo, Sawan, Kusum, Castor, Marua and Sweet potato are among those facing elimination from the doab. As a result, the number of crops earlier grown has declined while emphasis on the few more profitable crops has increased. As such, the change in the degree of crop-diversification and the volume of change in the crop-association is vivid in the doab.

Crop-diversification

The degree of diversification is expressed through indices. Indices are the measure of relationship which exist between the percentage strength of crops and the number of those crops grown during an agricultural calendar year. Here, the individual index of diversification for each of the components has been worked out by relating the number of crops grown to the percentage of land occupied by the same crops in the T.C.L. The index values according to Bhatia (1965) have been computed as follows

$$\text{Index of diversification} = \frac{\text{\% of crops occupying more than 5\%}}{\text{Number of crops occupying more than 5\%}}$$

Accordingly, if a few crops occupy more than 5% of the T.C.L, the index value will be higher and if reverse, it will be lower. That means that higher the value, lower the degree of crop- diversification and vice-versa. The degree of crop-diversification calculated as above, has under gone drastic

change during 1960-61 and 1990-91.

Table 7: Degree of crop-diversification 1960-61 and 1990-91

Anchal	Index (1960-61)	Index (1990-91)	Anchal	Index (1960-61)	Index (1990-91)
Chapra	15.31	21.17	Parsa	13.49	29.37
Revelganj	15.06	19.69	Taraia	13.77	20.55
Jalalpur	15.05	23.87	Mashrakh	13.58	28.88
Garkha	15.21	22.26	Manjhi	13.72	21.75
Baniapur	15.51	27.66	Ekma	13.59	22.35
Marhaura	14.70	20.47	Dighwara	15.26	22.54
Amnour	15.19	27.06	Sonepur	16.03	21.86
Dariapur	15.42	30.15			

***Source*:** Jeanswar, 1960-61 and 1990-91

It is evident from Table-07 that a decline in diversification is visible throughout the doab. In Parsa and Amnour anchals, it has diminished from high to low while in a large number of the anchals it has moderately decreased from medium to low. That means that emphasis is now on a few of the principal crops such as wheat, rice and maize. Specially, the HYV of wheat, rice and maize have gained exceptional popularity during the recent years. As a result, a large number of the minor pulses and millets have disappeared from the scene. So, there is a decline in the degree of crop-diversification almost everywhere in the doab. Yet, it does not suggest any trend of specialization in one or a few of the selected cereals. This simply shows that the farmers in common are inclined to adopt the modern varieties of cereals. The change in case of pulses is not promising. The loss of pulses is a loss of protein. So, it is a loss for the vegetarian population of the doab. For the non-vegetarians however, there is a scope of compensation from the piggery, fishery, poultry and goatery.

Crop- combinations

The crop-combination is not only a mere concept but an integrative reality as well that demands definition, interpretation and description. The combinations worked out are not self-determined, rather they have been developed by academic endeavours. It not only shows territorial differentiation in agriculture but also it helps to highlight the features of areal interest or problem (James, 1964). Weaver's contribution in this direction is popular and pioneer the world over. In this technique, the S.D. or D^2 denotes the minimum deviation from the theoretical value. The actual combination is decided by the least variation from the theoretical combination (Singh, 1976). It is obtained when the standard deviation will become the lowest. Weaver's formula is presented in the following format

$$D = \frac{d^2}{n} \text{ or S.D. } = \frac{(Xi - Ei)^2}{n}$$

in which d is the difference between the observed percentage and the theoretical value.

Xi is the observed percentage,

Ei is the theoretical value and

n is the number of crops

The crop-combinations according to Weaver Albeit (1954) being based on the precise and scientific method, have no bearing of the physical conditions of land in the doab. The primary crop-combinations based on Doi (1957) also fail to provide crop-combination showing bearing of the physical conditions. Yet, being simple and easy, it is very suitable for the Bihar plain.

Weaver's technique of calculating change in Crop-combination here has been used to show the change in Crop-combinations. It is as follows

$$\text{Chapra} = \frac{\text{Increase R1.05+W29.19=30.24}}{\text{Decrease M0.37+ P3.96+0S4.19=8.52}}$$

The increase above in the percentage of all those crops which occupy more than 5% of the total cropped land, has been put in the numerator while the decrease has been placed in the denominator. The values of numerator and denominator are summed up separately. The largest of the two digits i.e. 30.24, shows percentage of land involved in the change.

The volume of change has been illustrated in Fig.1.2. Evidently, there is spatial variation in the volume of change which has occurred in the crop-combination between 1960-61 and 1990-91. In a very big zone, the volume of change ranges from 30 to 40 percent. In Amnour it ranges over 40 percent while in Mashrakh, it is under 20 percent.

The volume of change can further be corroborated from the dislodgement of crops from crop-combinations (Fig.1.2 d). Minimum of one crop has been lost in general while up to 2 and 3 crops are also not uncommon. In short, the changes may be summed up as follows

a. The crop-combinations, after Green-revolution have become by far the most unstable.
b. The instability in crop-combinations is comparatively more marked in the flood- protected sections of the doab.
c. The Ganga-side flood-prone anchals are the least unstable. Here change and modification in crop-combination are difficult. The vagary of river is prohibitive to change for the betterment. Presently however, the rural development consequential to the setting of Rail wheel factories at Bela in Dariapuranchal and at Marhaura in Marhaura anchal, has made the area well-protected from the flood with the help of metalled roads and well-built embankments.
d. Yet, changes in crop-structure are more probable in favourable physical conditions than in an adverse physical environment.

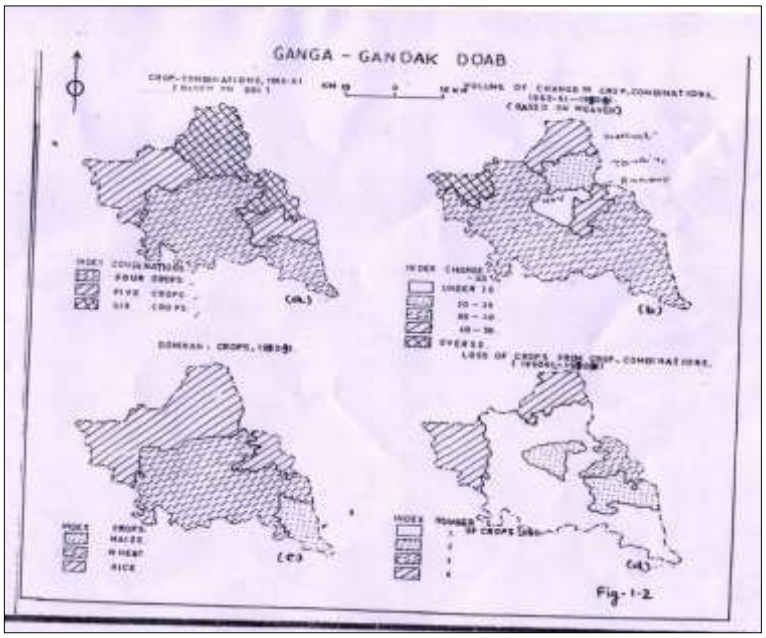

Fig 2

Conclusion

The agricultural change to contain the pressure of population as highlighted above, has entailed into the miraculous increase in the yield of cereals (rice, maize and wheat) per unit area of land. It is two-fold to three-fold in case of wheat, rice and maize. But it is not true of the per-capita increase in the food-grain since there has been no halt on the growth of population till 2001. The decline in percentage growth however, from 26.86% in 2001 to 21.54% in 2011, may be a matter of relief for the planners and policy-makers but in fact, as the experience shows, it has not been equally shared by all categories of the population. So, the assumption of sustainable agricultural growth, is not free from the apprehension of being again behind the growth of population.

It appears that the time has come to take benefit from the Nature's endowment that is available in the agro-biodiversity of the region under review. The agricultural change so far has brought about horizontal and vertical extensions in the cultivation. The increase in area of the gross-cropped land denotes horizontal extension while the vertical has been represented by increase in the yield per unit area of land. The former in the form of horizontal direction has reached saturation and the latter too has to face limitations sooner or later according to the economic principle of diminishing return.

The scope of vertical extension however, is still available in the agro- biodiversity of the doab. The desilting of Mahi river and its inter – linking with the Gandak-canal system in Saran district will provide ample opportunity for the fishery. Here river-water with respect to the pH value (07) is very suitable for the fishes. Likewise, for the poultry, piggery, goatery and dairy, there is adequate scope with least pressure on the land and in return these enterprises will enlarge the scope of corn-cultivation which provides nutritive as well as palatable fodder for the cow, pig, goat, sheep, hen and buffalo. The cow-dung and the excreta of others may also be used as organic manure in the agricultural fields. The sheep, allowed to pen down in fields will also make the land fertile and productive.

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