www.ThePharmaJournal.com

The Pharma Innovation

AP Chavhan
Post Graduate Student, College of Agriculture, Shivajinagar, Pune, Maharashtra, India

Dr. JS Kumbhar
Assistant Professor, College of Agriculture, Shivajinagar, Pune, Maharashtra, India

Dr. US Bondar
Assistant Professor, College of Agriculture, Karad, Maharashtra India

CS Shinde
Post Graduate Student, College of Agriculture, Shivajinagar, Pune, Maharashtra, India

Ecological implications of land use dynamics in Western Maharashtra

AP Chavhan, Dr. JS Kumbhar, Dr. US Bondar and CS Shinde

Abstract
Land is a limited natural resource throughout the whole world and its judicious utilization is crucial for economic acceleration and progress of any country throughout the whole world. It is crucial for both the areas, be it agricultural or non-agricultural. An investigation of the structural modifications to the land use pattern for a certain period of time gives room for thoughtful and well-planned land management. Accordingly, the current research on 'Ecological Implications of Land Use Dynamics in Western Maharashtra' was carried out. For the analysis, Secondary data sources were consulted in order to assemble the required state-level time series data on the area classified under land use categories such as 'Statistical Abstract of Maharashtra' and other publications issued by the Government. The total time period of 1960-61 to 2019-20 was subdivided into three distinct periods, viz; Pre- liberalization (from 1960-61 to 1990-91), Post-liberalization (from 1991-92 to 2019-20) and Overall time period (from 1960-61 to 2019-20). Annual rates of change were calculated to research the movement in land usage within and between sectors. Ecological repercussions of land use dynamics in Western Maharashtra concluded that, land shift under wasn't found commending in Period II, where the desirable ecology's land usage has been shifting in the direction of the agricultural and non-agricultural sections, the shift of land from a desired sector to undesirable environmental state could have long-term detrimental effects on the environment. The land use shift from a desirable to an undesirable environmental sector might have detrimental long lasting effects on the ecosystem. Therefore, strategies to promote rural and agricultural development should be integrated, such as, Pradhan Mantri Krishi Sinchai Yojana (PMSKY), National Mission for Sustainable Agriculture (NMSA), Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA), etc., are essential for holistic development of rural areas, the administration of natural resources, and ecological restoration, as well as for using barren and unsuitable for cultivation land for cultivating crops.

Keywords: Land use dynamics, land use category, ecological implications, desirable ecology, annual rate of change, inter sectoral, intra sectoral

Introduction
The land is a fundamental component of agriculture and holds a significant place among the many resources needed for a present-day economy. (Ramasamy *et al*., 2005) [4]. The difficulty of increasing agricultural production around the globe is largely dependent on how water and land resources are handled. Food insecurity is anticipated to become more prevalent because of population pressures, climate variability, and intense demand for water and land resources. The bigger difficulty now is feeding everyone on the earth enough food. (Anon., 2011) [5].

Land being a non-renewable natural resource must be managed effectively for the nation's development and economic prosperity. Land use, often known as land utilization, is essentially and practically an action taken by the local populace to satisfy their needs. The utilization of the limited amount of land between the agricultural and non-agricultural sectors is typically governed by demand. The manner and intensity of a country's land use determine its economic growth rate. The land is essential for growing crops such as cereals, pulses, and other foods as well as surpluses that can be used to meet the demands of the population that has been increasing continuously. The establishment of a transportation network, communication, building of homes and public institutions, planning its exploitation for economic progression, and judicious land usage are prioritized for environmental reasons in the developing industrial sector. (Gairhe, 2011) [6].

Land use is an extremely dynamic activity; land use dynamics of any region is influenced by the local physical environment and population strain on the land. The phrase "land use pattern" refers to the percent of an area that is used for different purposes, such as the area that is really farmed, forest land, fallow land, pasture land, area under settlements, and so forth.

Corresponding Author:
AP Chavhan
Post Graduate Student, College of Agriculture, Shivajinagar, Pune, Maharashtra, India

An area's land use trend is influenced by physical, ecological, and demographic demand on the land. Considering all these aspects, land use dynamics in Western Maharashtra was studies with an objective of analyzing the ecological implications of land use dynamics.

Methodology
For analysing the land use dynamics, Western Maharashtra region was chosen, the research was carried out using sources that were secondary and the required region level data was compiled for the period from 1960-61 to 2019-20. The time series data which was acquired throughout the course of (1960-61 to 2019-20) was furthermore categorized into three separate sub-intervals.

As Period I (Pre LPG) from 1960-61 to 1990-91 and Period II (Post LPG) from 1991-92 to 2019-20 and overall time period from 1960-61 to 2019-2020.

The dynamics of shifting land uses were investigated with the assistance of simple identity of linearly additive changes in land usage (Gairhe *et al.,* 2011) [6]. The area under all land-use classifications was linearly totaled up by the first accounting identity, and this amount equaled the total reported area, given by equation (1):

$$R = Fr + P + M + N + U + W + Fc + Fo + C \qquad (1)$$

Where,
R = Total reporting area ('00 hectares); Fr = Area under forest ('00 hectares);
P = Area under permanent pastures ('00 hectares);
M = Area under miscellaneous tree crops ('00 hectares); N = Area under nonagricultural uses ('00 hectares);
U = Barren and uncultivable lands ('00 hectares); W = Cultivable wastes ('00 hectares);
Fc = Current fallows ('00 hectares);
Fo = Fallows other than current fallow ('00 hectares); C= Net area cultivated ('00 hectares).

Also, $\Delta R = \Delta Fr + \Delta P + \Delta M + \Delta N + \Delta U + \Delta W + \Delta Fc + \Delta Fo + \Delta C$ (2)

Where, Δ denotes the change.

It is convenient to divide the entire land resources into three major sections, *viz.* (i) ecological sector (E) consisting Fr, P, M and U, (ii) agricultural area (A) consisting W, C, Fc and Fo and (iii) nonagricultural (NA) area. Two additional subsectors were created out of the ecological sector, *viz.* (i) the desirable ecology (E1) consisting Fr, P and M, and (ii) undesirable ecology (E2) consisting U. Then, each sector's net shifts can be estimated as:

$$\Delta E = \Delta E1 + \Delta E2 = (\Delta Fr + \Delta P + \Delta M) + (\Delta U) \qquad (3)$$

$$A = \Delta Fc + \Delta Fo + \Delta W + \Delta C \qquad (4)$$

Since switching from the non-agricultural to the agricultural sectors of land usage is not possible the net changes made in the agriculture sector would have detrimental effects on the environment If this net change is positive (+ΔA), the ecological sector will suffer as a result.; If -(ΔA) is negative,

there could be a change in land use towards either the ecological or non-agricultural sectors, or both but unquestionably at the expense of the agriculture sector. Furthermore, the agricultural sector's transformations will have an impact on the environment and/or the expansion of agriculture.

It is possible to budget for the whole inter-sectoral land use shifts as:

$$\Delta R = \Delta E1 + \Delta E2 + \Delta A + \Delta N \qquad (5)$$

Using land use time series data for both districts and the state, linear time trend equations were approximated to determine the annual rate of change in different land use categories Equations (3), (4), and (5) were used to calculate the annual rates of change in the various classes. These equations make it easier to analyse the dynamics and direction of land use transitions.

Results and Discussions
Ecological implications of land use dynamics
It was convenient to divide the entire land resource into three substantial parts., viz., (i) Ecological sector consisting of forest, permanent pastures and other grazing lands, miscellaneous trees and groves which is not included in the net area sown and barren and uncultivable land (ii) Non-agricultural sector consisting of area involving non-agricultural purposes, and third sector is (iii) Agricultural sector consisting of cultivable wastes, current fallow, net area sown and fallows other than current fallow. This led to theories on the potential paths of significant intra- and inter-sectoral land use shifts.

Intra-sectoral dynamics of land use
In this section, an effort has been made to assess the absolute average annual changes in hectares terms in respect of each of the land use category for further budgeting of inter- sectoral land use shift.

Intra-sectoral dynamics of land use in Western Maharashtra
A perusal of Table 1 indicates the annual rate of change in land use categories of Western Maharashtra region. The findings showed that the amount of land used for non-agricultural purposes increased by 45.03 and 118.66 hundred hectares, respectively, over Periods I and II.

As far as the ecological sector is considered, annual rate of decline of area under forest was lower in Period II in contrast with Period I. Forest area indicated an annual decline of 10.47 and 7.55 hundred hectares during Period I and Period II, respectively; on the other hand, annual rate of incline of permanent pastures and other grazing land was 24.53, 26.69 and 25.59 hundred hectares during Period I, Period II and Overall Period, respectively. In case of barren and uncultivable land, during Period-I, annual rate of decline was 3.60 hundred hectares while during Period-II, there was a massive growth in annual rate of change. Annual rate of incline was 44.69 hundred hectares, during Period-II, while during Overall Period, annual rate of incline stood at 20.14 hundred hectares.

Table 1: Intra-sectoral dynamics of land use in Western Maharashtra region

(Annual rate of change in '00' ha)

Land use sector	Land use category	Period I	Period II	Overall Period
Non-agricultural	Land put to non-agriculture uses	45.03	118.66	81.22
Ecological	Forest	-10.47	-7.55	-7.55
	Permanent pastures & other grazing land	24.53	26.69	25.59
	Barren and uncultivable land	-3.60	44.69	20.14
Agricultural	Cultivable waste	-9.43	6.79	-1.46
	Current fallow	36.70	83.14	59.53
	Fallow other than current fallow	-16.90	34.17	8.20
	Net area sown	-72.77	-316.00	-192.32

As far as the agricultural sector is considered, area under cultivable waste showed an increase of 9.43 hundred hectares per annum during Period I, while annual rate of decline was 9.43 and 1.46 hundred hectares during Period II and Overall Period, respectively. Even after being an undesirable land use category, current fallow seemed to increase during all the periods under study. In terms of fallow lands annual rate of incline was 36.70, 83.14 and 59.53 hundred hectares during Period I, Period II, and Overall Period, respectively. Annual rate of decline was 16.90 hundred hectares during Period I while it increased in the later Period. Annual rate of incline was 34.17 and 8.20 hundred hectares during Period II and Overall Period, respectively.

As a desirable land use category, net area sown is expected to increase, but it showed a decline of 72.77, 316 and 192.32 hundred hectares per annum during Period I, Period II and Overall Period, respectively.

Inter-sectoral land use shift budgeting
In this part, an estimation of the land use shift between the major land use sectors has been attempted. When it comes to inter-sectoral land use dynamics, the ecological sector will suffer if the net change in the agricultural sector is positive

($+\Delta A$), considering the likelihood of land shifting from the non-agricultural to the agricultural sectors is low. However, if the net change in the agricultural sector is negative ($-\Delta A$), either the non-agricultural or ecological sectors (desirable and/or unwanted sub-sector) or both may be to blame for the change in land use. The dynamics of land usage in the agriculture sector will also have significant effectsA favourable environment for agricultural growth would exist if there is both an increase in the net area cultivated and a positive net change to the agricultural sector ($+\Delta A$). However, it would indicate a situation where there is an increase in the cultivated area if there is no addition to the net area sown, on the one hand, and reduction in the amount of land used for cultivation by changes to currently fallow, fallows other than current fallow, and cultivable waste, on the other, so maintaining a constant net sown area.

Inter-sectoral land use shift budgeting in Western Maharashtra
The purpose of the inter-sectoral budgeting was to determine the dynamics of land-use transition and their pattern in Western Maharashtra region and Table 2 presents the findings.

Table 2: Inter-sectoral dynamics of land use in Western Maharashtra region

(Annual rate of change in '00' ha)

Sr. No	Land use sector	Period I	Period II	Overall
1	Ecological ($\Delta E = \Delta E1 + \Delta E2$)	18.50	73.17	45.37
a.	Desirable ecological ($\Delta E1$)	22.10	28.48	25.24
b.	Undesirable ecological ($\Delta E2$)	-3.60	44.69	20.14
2	Agricultural (ΔA)	-62.40	-191.90	-126.05
3	Non-agricultural (ΔN)	45.03	118.66	81.22
4	Net sectoral changes	1.13	-0.07	0.54

Note: The net sectoral change is equal to algebraic sum of $\Delta N + \Delta E1 + \Delta E2 + \Delta A$

During Period I, land under ecological sector inclined significantly at an annual rate of 1850 hectares. The desirable ecological sector surged by 2210 hectares while undesirable ecological sector declined by 360 hectares annually, depicting favorable land use shift in both sub-sectors of ecology sector. In case of agricultural land, there was a decline of 6240 hectares while in case of non-agricultural an incline of 4503 hectares per annum was observed. During Period II, it was noticed that, area under ecological sector increased by 7317 hectares annually. Desirable ecological sector and undesirable ecological sector increased by 2848 and 4469 hectares annually. The reduction in the agricultural sector was continued in even Period-II, in which there was a decline of 19190 hectares per annum while in case of non-agricultural land, there was a remarkable growth at the annual rate of 11866 hectares. As compared to Period II, inter-sectoral budgeting was more favorable in Period I. Although there was a notable growth in ecological sector in Period II, there was

remarkable increase in non-agricultural land while agricultural land kept going down rapidly as well.
During Overall Period, ecological sector increased by 4537 hectares per annum. Desirable ecological and undesirable ecological sector both inclined by 2524 and 2014 hectares per annum, respectively. Agricultural land saw the reduction of 12605 hectares per annum while non-agriculture land increased by 8122 hectares, annually.

Conclusions and Policy implication
The inter-sectoral budgeting analysis was carried out to determine the dynamics of land use changes and their pattern and scope. It can be concluded that as compared to Period- I, inter-sectoral budgeting in ecological sector was more favorable in Period II, although land under ecological sector increased during both the periods, eventually. During Period I, area under ecological sector increased by 4503 hectares per annum while during Period II, it surged by 11866 hectares per

annum. Undesirable ecological sector was more favorable in Period II while during Period I, the annual rate of change for the same was negative. Agricultural land decreased more in Period II while non-agricultural land surged massively during both the periods.

The land use shift from a desirable to an undesirable ecological sector might have detrimental long term effects on the ecosystem. Thus, initiatives related to rural and agricultural development should be integrated, such as, Pradhan Mantri Krishi Sinchai Yojana (PMSKY), National Mission for Sustainable Agriculture (NMSA), Mahatma Gandhi National Rural Employment Guarantee Act (MNREGA), etc are required for comprehensive rural development, the administration of natural resources, and ecological restoration, as well as for the utilization of barren and uncultivable land for cultivation.

References

1. Amale AJ, Shiyani RL. Ecological implications of land use dynamics in Gujarat. Agricultural Situation in India. 2018;75(11):37-43.
2. Mouzam SM, Hile RB, Swaminathan B, Khan M. Dynamics of land use and cropping pattern in Andhra Pradesh. Trends in Biosciences. 2015;8(6):1400-1405.
3. Singh M. Projection of land use pattern in India: A Markov chain approach. Ann. Agric. Res. New Series. 2012;33(1 & 2):69-78.
4. Ramasamy C, Balasubramanian R, Sivakumar SD. Dynamics of land use pattern with special reference to fallow lands- An empirical investigation in Tamil Nadu. Indian Journal of Agricultural Economics. 2005;60(4):629-644.
5. Anonymous. The State of the World's Land and Water Resources for Food and Agriculture (SOLAW) - Managing Systems at Risk. Food and Agriculture Organization of the United Nations, Rome and Earthscan, London; c2011.
6. Gairhe S. Land use dynamics in Karnataka- An economic analysis. Unpublished M.Sc. (Agri.) thesis submitted to the University of Agricultural Sciences, Dharwad, Karnataka; c2011.