MA (ECONOMICS)

FINAL SEMESTER

MAECO504

ENVIRONMENT, POPULATION AND AGRICULTURE

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SYLLABI-BOOK MAPPING TABLE

PAPER NO: MAECO504
ENVIRONMENT, POPULATION AND AGRICULTURE

SYLLABI **Mapping in Book**

UNIT-I: THE ECONOMY AND THE ENVIRONMENT

Components of Environment - Interlinkage between Economy and Environment - Environmental Economics vs Natural Resources Economics - Common Property Resources - Open Access - Tragedy of Common - Environmental Degradation as market failure – Externality - Coase theorem: Market efficiency through negotiation - Critical evaluation

UNIT - II: ENVIRONMENTAL VALUATION

Use value and non-use value - Contingent Valuation method - Hedonic Pricing - Travel Cost Method (TCM)

UNIT - III: ENVIRONEMNT AND DEVELOPMENT

Environment and Development trade-off - Population, Poverty and Environment - Trade and Environment - Concept of Sustainable Development - Indicators of sustainable Development - Rules to sustainability - Concept of Green Accounting

UNIT IV - POPULATION GROWTH AND FERTILITY

Trends of population growth since the beginning of 20^{th} Century - Basic measures and concepts in Demography - Basic Demographic Equation - Demographic Data Sources - Censuses: Definition given by the United Nations handbook of the Census (1958) - Vital Statistics - Basic Measures of Fertility - Types of Analysis: Period and Cohort measures - Child-Women Ratio (CWR) - Crude Birth Rate (CBR) -General Fertility Rate (GFR) – Age-specific Fertility Rates (ASFR) - Total Fertility Rate (TFR) - Gross Reproductive Rate (GRR) - Net Reproductive Rate (NRR) -Economic Theories of fertility

UNIT- V: MORTALITY

Measures of Mortality-Life Table- Trends of Mortality in Developed and Developing Countries - Mortality trends country wise -Determinants of Mortality

UNIT-VI: INTRODUCTION TO AGRICULTURAL ECONOMICS

Nature of Agricultural Economics - Interdependence and Complementarities between Agriculture and Industry -Agriculture, Poverty and Environment Farming Systems - Farm Size and Practices - Farm Efficiency Measures - Resource Management in Agriculture

UNIT- VII: ISSUES IN FARM MANAGEMENT

Nature of Agricultural Production Function: Cobb-Douglas - Nature of Agricultural Production Function: Spillmans- Risk and Uncertainty in Agricultural Production and Prices - Decision theory - Cobweb Theorem -

Nerlove's Model - Agricultural Marketing - Marketed and Marketable Surplus - Mathur-Eizkel Hypothesis - Farm Size and Productivity - Pricing policy (including support price)

UNIT –VIII: THEORIES OF AGRICULTURAL DEVELOPMENT

Lewis Model - Jorgenson's Model - Theories of Agricultural Development: Schultzian Theory - Mellor's theory of Agricultural development - Boserup's Theory of Agricultural Development - The Chayanov Farm Household model - Barnum–Squire Farm Household Model - The Low's Model of farm household

UNIT – IX: INSTITUTIONS AND AGRICULTURE

Land Tenure System - Tenant-Landowner Model: Marshall and Cheung Models - Rural credit market - Monopolistic credit market - Characteristics of semi-feudalism - Stagnation under semi-feudalism- Bhaduri's model

UNIT- X: ISSUES IN AGRICULTURAL DEVELOPMENT IN INDIA

Agricultural System in India - Problems of Diffusion of New Technology - Limited spread of Green Revolution - Food Security - The State and Agriculture - WTO and Indian Agriculture -

Contents

UNIT IV - POPULATION GROWTH AND FERTILITY

UNIT- V: MORTALITY

UNIT- X: ISSUES IN AGRICULTURAL DEVELOPMENT IN INDIA

Introduction of the book

The book consists of ten units about the environment, population and agriculture.

In the first unit of this book, we have discussed the economy and the environment. In this unit, the students will learn about the components of an environment, inter-linkages between the economy and the environment, environmental economics vs. natural resource economics, the tragedy of commons, environmental degradation as market failure, externality, Coase theorem and market efficiency.

Environmental degradation is concern for every society and nations of the world. Therefore, many measures have been taken up in society level to improve the quality of the environment or to reduce environmental degradation. Hence, the types and methods of environmental valuation are discussed in unit two of this book.

Unit three deals with the relationship between environment and development. One of the main reasons for the degradation of an environment is economic development. Therefore, in this unit, we have discussed the causes of environmental degradation due to economic development and their corrective measures.

Population growth is often said to be one of the main factors behind India's backwardness. For any student of demography, it is important to have a clear understanding of the size and growth of population, the reasons for the changes in growth rates of population and the factors which determines its growth. Therefore, we have discussed the population growth and fertility in unit four of this book.

Mortality analysis is one of the most important branches of demographic studies. This branch deals with the measurement of mortality. Thus, the techniques for analyzing mortality have a long history and are more developed than those for analyzing fertility. In this regards, different measures and determinants are discussed in unit five of this book.

In unit six of this book, we have elaborately discussed the nature of agricultural economics, interdependence and complementarities between agriculture and industry.

The nature of agricultural production function, risk and uncertainty in agricultural production and its prices have been examined in unit seven of this book. Further, decision theoryis comprehensively explained.

In unit eight of the book, we have discussed various theories of agricultural development which are applicable to underdeveloped countries.

The unit nine elaborately discussed about the rural credit market, understand the various theories, model of rural credit and impact of share tenancy system.

Finally, in unit ten of this book, we have discussed about the agricultural system in India, Problems, Green Revolution, Food Security, WTO and Indian Agriculture.

UNIT-I
THE ECONOMY AND THE ENVIRONMENT

Structure

1.0 Introduction

Environmental Economics is concerned with the importance of environment in economy and impact of various economic activities on the environment. The environment, in-turn, have but limited carrying capacity, beyond which it becomes not only unsustainable but also may have perverse implications upon economy itself. It is in this context that the significance of environment is raised with respect to economy. In this unit the focus is upon several dimensions of environmental economics which may relates to the necessity of formulating basis of environmental policies.

1.1. Objectives

The following are the learning objectives of this unit-

- Components of environment
- Inter-linkages between the economy and the environment

- Environmental economics vs. natural resource economics; Common Property Resources
- Open Access, tragedy of Commons
- Environmental degradation as market failure
- Externality
- Coase theorem, market efficiency through negotiations, critical evaluation.

1.2. Components of Environment

Generally, environment refers to all conditions and their effects which influence the life of a man at any place and at any time. Or, it refers to all those things which are surrounding by the earth. According to the Environment Act 1986, "Environment includes water, air and land and the inter-relationship which exists among and between water, air, land and human beings and other creatures, plants, micro-organism and property".

There are mainly two components of environment:

a. Biotic or living.

b. Abiotic or non-living.

Both these elements are interdependent and they influence each other. With change in Abiotic element, there is also a change in living element of environment. Likewise, a change in living element brings about a change in physical element of environment. Abiotic component includes all physical, non-living elements that provide sustenance to the living organisms.

The Abiotic component of our planet consists of the following categories:

i. The solid matter of the earth starting with top soil or dust and all its solid components.

ii. The water in the ocean and in the rivers, lakes ponds, including marshes and wetland.

iii. The gaseous components around us including nitrogen, oxygen and water vapour called the atmosphere.

The biotic component that includes all living organisms, that is all life forms that follow the process of birth and death.

i. Plants, that depends primarily upon soil nutrients, water and sunlight.

ii. Animals including reptiles, rodents, insects, birds and fishes.

iii. Man, though strictly speaking, a part of the animal category is being considered a separate group here for his capacity to adapt and modify nature with the use of technology.

iv. Micro-organisms including parasitic and saprophytic bacteria and fungi, which are very small and may often be invisible to the eye, but feed primarily upon other living or dead organisms also some non-biotic elements.

1.3. Interlinkage between Economy and Environment

Environmental economics attempts to study the inter relationship between economic agents and environment. Economic as a subject cannot exist in isolation, it cannot even be a mere study of how good and services are produced, but at the same time it has to take into consideration the impacts of the use of resources on the environment. The impact may be in the form of externality, pollution, exhaustion, etc. Any study on the economic content of production, distribution, development, etc., cannot be completed without touching upon the environmental aspects like externality, pollution, damage, exhaustion, depletion etc. environmental economics can therefore be defined as that part of economics which deals with interrelationship between environment and economic development and studies the ways and means by which the former is not impaired nor the letter impeded. Environmental economics teaches us how to promote economic growth of nations with least environmental damage. When the environmental goods get transferred into economic goods, the problems of environmental damage crop up and therefore the need to interact with economic principles.

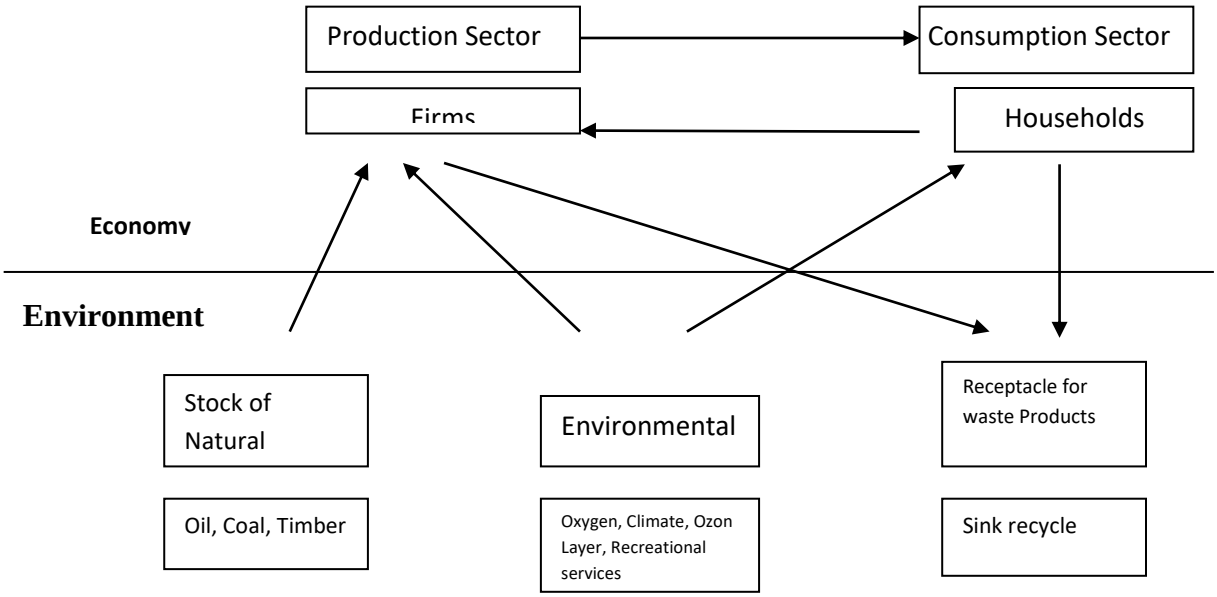
One must begin by recognizing the threefold connection between the environment, human society and its economy.

First, the environment provides the economy with raw materials which are transformed into consumer products through the production process. These raw materials include energy, which is itself a consumer product as well as an intermediate that drives this transformation.

Second, the environment provides services which are used directly by consumers. These may be critical life-support services such as the oxygen in the air that we breath or the water that we drink. They may be aesthetic or recreational services that we may derive pleasure from, such as rambling in the forest or boating on the river.

Finally, there is a less recognized but vital service that the environment provides to the economy. It act as a receptacle or a sink for all the waste products that are the result of the process of production and consumption. The environment is not a passive sink, it act upon the waste products to clean up the environment and recycle the waste intp material that can be used again.

These inter linkages are given in the following diagram:



All problems relating to the degradation of the environment relates somehow to an interference that occurs in this relationship, that hinders the delivery of these good and services that are provided directly or indirectly by the environment to the economy. It may involve the slowing down or a complete break down of the natural clean up process. It is this interference or obstacle that lies at the root of all environmental problems.

Let us take a simple example, if a factory produces some good, it also produces smoke. The amount of good it produces is decided by the economy. This in turn decides the amount of smoke that will be belched out and the damage to human health it will cause. If your neighbor plays his music system too loudly, your mental peace is disturbed.

Thus all problems of environmental pollution or degradation occure as a by product of our activities related to production or consumption. It is therefore, important to understand

the economic forces that derive production and consumption such as the formation of market prices and the optimal allocation of inputs.

1.4. Environmental Economics vs Natural Resource Economics

Prior to 1980's little attention was paid to the study of environmental economics. Instead, the theory that was being popularized among the social scientists was known as resources economics. Until the early 1950's natural resource supply and conversation had been neglected by modern economists. Orris C. Herfindhal was the first to go beyond descriptive survey and to view mineral resources as economic goods. Therefore resources economics was concerned with the production and use of natural and mineral resources of both renewable and non-renewable character. The pollution aspect of resource use was not a concern of resource economists. They traced resource economics as flows with dynamic factors.

Environmental economics is concerned with the impact of economic activities on the environment, the significance of ecosystem to the economy and suggest the appropriate ways of regulating economic activity, so that cosmic balance is achieved in the society. Resource economics does not bother about the environmental impact of production and consumption, but environmental economics deals with these aspects. Environmental economics point out the "right volume of pollution" which the society can bear. In order to attain this 'balanced' level of production and pollution, economists recommended economic tools like market mechanism principles. This is so because, in the case of environment, market fails to bring equilibrium. Market fails because environment is a public good. But by assigning true values to the environmental goods it is possible to apply market mechanism principles. These aspects are covered in environmental economics which distinguishes it from resources economics.

1.5. Common Property Resources

Common property resource means a good or service shared by a well-defined community. The community controls the use of such resource by individuals. However, enforcement is weak due to difficulties in monitoring. For example, water in a village pond, which is a common property resource, is used by the villagers only. The village as a

community decides upon the manner and the purpose for which the pond water can be used, which results in a set of norms, evolved over time, and largely unwritten. In case of a breach of the norms, however, imposition of penalty is poorly enforced due to poor monitoring, subjectivity in the norms and ambiguities in property rights. The common property regime for managing natural resources is frequently misunderstood. It is often observed as a situation in which there is no management regime in place; as a situation of open access, which is free for all. Accordingly, resource degradation in the developing countries is incorrectly attributed to 'common property systems', whereas it actually originates in the dissolution of local , level institutional arrangements. Therefore, there is a need to properly understand the common property resources and its management systems as these have direct bearing on the sustainable development of natural resources.

We can list a large number of CPRs, which can be brought under the broad headings like land resources, forest resources, water resources, and fishery resources. These resources are being degraded overtime due to overuse or lack of proper management. We shall discuss briefly about these common property resources.

Land Resources

Common property land resource refers to lands identified with a specific type of property rights. The common lands covered in the National Sample Survey (NSS) enquiry are panchayat lands, government revenue lands, village common lands, village thrashing lands, unclassified forest lands, woodlands and wastelands, river banks, and lands belonging to other households used as commons.

Forest Resources

Another category of land for which common property rights may exist is land under forests. Unclassified forests, with very low productivity, are always open to use by local communities: Accordingly, both protected and unclassified forests are treated as forming a part of common property forest resources. It is, therefore, the subset of total forest area minus reserve forests to which common property rights are assumed to exist.

Water Resources

There are a variety of resources of water, which are in the public domain, and a significant part of these are included in the category of commons. Examples are flows of rivers, tanks and natural lakes, groundwater, wetland and mangrove areas, and such other water bodies. Man-made water resources such as dams and canals, tube wells, other wells, and supply of all types of potable water also fall in the category of CPRs depending upon their property rights. Unfortunately, even after many debates about property rights (such as traditional rights, community rights, and basic need human rights), water has not yet been declared as CPR in India, though references are made in the water policy document indirectly. By and large, water resources in India are in common property regimes only. Irrigation canals are managed jointly by the government and communities. Traditionally, tanks, village ponds, and lakes - all of which are treated as CPRs -are sources of water for drinking, livestock rearing, washing, fishing and bathing, and several sanitary-related activities.

1.6. Open Access

Basically, it is a situation where there are no enforceable property rights over the use of the resource. Here, a right of inclusion is granted to anyone who wants to use the resource. Examples of open access resources are fishing in the open sea, river, lake, or ponds, ill-managed village common grazing lands, buffer areas of forests, groundwater, etc. Open access results from the absence - or breakdown - of a management and authority system whose very purpose was to introduce and enforce a set of norms of behaviour among participants with respect to the natural resource.

1.7. Tragedy of Common

People have always a tendency to use (misuse) public property according to their whims and fancies. As the public property is not owned by any individual, no one can claim for an exclusive ownership. The net result being misuse of public properties. Perhaps this is the main reason for garbage appearing in the public road, discharging effluents into the river, public parks being misused, public buildings being disfigured etc.

Prof. Garrett Hardin examined the reasons why public properties are either being misutilised or over utilized by the people. The answer that he identified has been published in the article titled “The Tragedy of commons” (1968). He had studied the character of herdsmen in England. Hardin anxiously watched out the peculiar behavior of herdsmen that they are always prepared to add additional cattle into the pasture land in England. The logic prevailed that the farmer who grazed the most cattle stood to benefit most from the commons. But the tragedy of this kind of action is that the land was overgrazed and destroyed. This came to be known as “ Tragedy of Commons” . Though the tragedy of commons is an observation based on the real experience example, it finds its applicability in most of the situation in which the resources are owned by the public. There is a tendency to over exploit public resources resulting in total destruction or non-availability of further resources’.

1.8. Environmental Degradation as market failure

1.9. Externality

Externality is defined as conditions arising when the actions of some individuals have direct (Positive or Negative) effects on the welfare or utility of other individuals none of whom have direct control over that activity. In other words, externalities are incidental benefits or costs to others for whom they are not specifically intended.

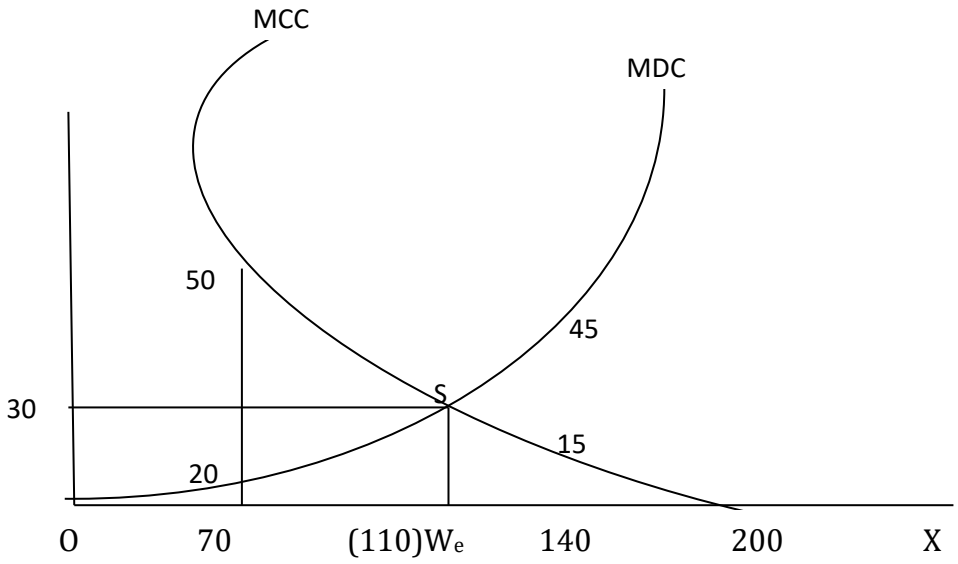
Two classic example of externality are explained below. One is represented by the action of a gardener who invests in the beautification of his or her own property and in doing so raises the property value of neighboring houses. A second example is represented by a fish hatchery plants that has to bear the cleaning up costs for the wastes discharged by a paper mill near to it. In the first example, the neighbours are gaining real external benefit (Positive Externalities) without sharing the cost that yield beneficial results. In the second case the cleaning up costs of the hatchery is external (Negative externality) since it is the result of an action imposed by a third party i.e., the paper mill.

1.10. Coase theorem: Market efficiency through negotiation

According to Coase, any effort to internalize environmental externalities requires an effective scheme for assigning property rights. Coase also believed that by assigning property

rights to at least one of the parties involved (either polluter or the pollutee) there would be no effect on the final outcome of the environmental problem. The Coase theorem developed by economist Ronald Coase in 1960. The advantages of this theory is that the pollution problem can be solved by an arbitrary assignment of property rights. Optimal level of pollution can be attained through voluntary negotiations of private parties (polluter and pollutee). If the state is acting as a regulator, enforceable ownership rights have to be assigned so that it can act as private enterprise.

To illustrate the essence of this theory, let us follow the example given below. The two familiar firms to be taken to explain this theory are the paper mill and the fish hatchery. River flowing nearby these firm are a common good. The fish hatchery believes that and as per the legal rights, the river can be used for its activities. The paper mill is not permitted to discharge the effluents into this river. In the figure, this situation is represented by the origin O, where the amount of waste released into this river from the paper mill is zero.



The figure explains that if the paper mill is not permitted to dispose of the wastes, it has to find an alternative method of disposal of 200 units of waste. But this system cannot sustain for a long period. When the waste discharged by the firm is less than W_e (110 units). The Marginal Cost of Cleaning (MCC) of the Mill is higher than the Marginal Damage Cost (MDC) to the hatchery. As shown in the figure, for the 70^{th} unit of waste emitted into the river, the MDC to hatchery is Rs. 20. The MCC of mill is Rs. 50. The Rs. 50 is for cleaning

up of 130 units (200-70=130) of wastes. To discharge 70 units of wastes, the mill is prepared to pay Rs. 20 to compensate for the damage caused to hatchery, because the alternative cost for waste disposal of 70 units is Rs. 50. This proposal is advantageous to the paper mill. Though both the parties, the paper mill and the fish hatchery, enjoy some advantages, they can think of a better bargain. These two firms will be in a position to engage in a mutually beneficial transaction provided that it is at the point where the MCC>MDC. Further the negotiation ends when the MCC=MDC. This is the condition for the optimum level of pollution. In figure this is attained at W_e or 110 units of waste emission.

Coase theorem goes beyond the mere attainment of optimally. It also states that this optimal outcome is completely independent of the two parties who have the rights to the river. To illustrate this, let us imagine that the paper mill has exclusive legal rights to the use of the river. Under this circumstance, the mill can dispose of the entire wastes to the river. The figure shows that the paper mill can discharge a total of 200 units. But for each units between 110 and 200 units of wastes discharged, the MDC is greater than MCC. It means that the mill's MCC for abating pollution is lower than MDC which the mill needs to meet. This situation will call for the two firms. The paper mill and the hatchery to engage in a mutually beneficial transaction. When the waste is 140 units, the control cost which the mill needs to pay to the hatchery is Rs. 15 per unit, whereas the mill itself needs to spend Rs. 45 to avoid the 1 unit of waste emission. Thus when the emission level is at 140 units, the MDC is greater than MCC. The hatchery will take initiative to offer any amount higher than Rs. 15 to avoid higher levels of pollution emission to the river. Thus, the hatchery moves on the MCC curve and finally, it settles at S where MDC=MCC. Thus the optional level of pollution is again reached at W_e or 110 units where MDC=MCC.

The theory based on several assumptions:

a. Every firm has perfect information
b. Consumer and producers are price takers
c. Producers maximize the profit and consumers maximize the utility
d. There are no income or wealth effects
e. There are no transaction costs.

1.11. Critical evaluation

The following major limitations of this theory are:

1. Wealth effect is assumed to be non-existent. But in reality we all of us know that there are wealth effects which are subject to environmental factors.

2. Complete set of property rights is necessary to obtain optimum allocation of resources. Coase says that for achieving efficiency it does not matter how these rights are distributed. The question who will assign property rights to public goods is still a hard nut to crack. Arbitrary valuation cannot be considered as the relatively better option.

3. The transaction costs will be much higher when the parties involved in the negotiation process are many.

4. Coase theorem appears to be indifferent from the polluter pay principal which states that it is the polluter who has to meet the environmental damage cost. The extent of optimality in the polluter pay principle is analysed in the Pigovian fee.

1.12. Questions

1. What are the various components of Environments? Also, discuss the various inter-linkages between economy and environment.
2. What do you mean by common property resources?
3. Discuss the concept of Tragedy of Common in the context of environmental economics.
4. State and illustrate the Coase Theorem.

1.13. Key Words

Components	:	Individual parts comprising the total
Inter-linkage	:	Inter-relationship between various individual sectors/parts
Tragedy	:	Misfortune
Utility	:	Amount of satisfaction derived from good

1.14. Suggested Readings

1. Hanley N, J.F. Shogern and Ben White, *Environmental Economics in Theory and Practice*, Macmillan, 1997.
2. Kolstad,C.D., *Environmental Economics*, Oxford University Press, New Delhi, 1999.
3. Sankar,U. (Ed), *Environmental Economics*, Oxford University Press, New Delhi, 2001.

Bhattacharya, R.N. (Ed), *Environmental Economics – An Indian Perspective*, Oxford University Press, New Delhi, 2001.

UNIT II
ENVIRONMENTAL VALUATION

Structure

2.0 Introduction

These days, environmental degradation is a great concerned for every nation in the world. Subsequently, many measures have been taken up in society level to improve the quality of the environment or to reduce environmental degradation.

2.1 Objectives

The following are the learning objectives of this unit-

- Types of environmental valuation
- Methods of Environmental valuation

2.2. Use value and non-use value

Economic value expresses the degree to which a good or services satisfies individual preferences. These preferences can be expressed in terms of utility but more practical in monetary terms. Thus, economic value can be measured by the amount of money an individual is willing to pay for a service or good or the amount of money an individual is willing to accept as a compensation for foregoing the good or service. The environmental goods have two types of value viz., use value and non-use value.

The environment has direct user value. User values are derived from the actual use of the environment. For example, the benefit that one derives from the provision of safe drinking water, pollution free air and so on. This is sometimes referred to as the instrumental/operational/ functional value which arises out of both actual current use and future potential use. When we value the environment for present personal use is the actual present value.

Non-use value is the value that people assign to economic goods (including public goods) even if they never have and never will use it. The non-use value is categorized into four parts. These are as follows-

Option Value: it is defined as the willingness to pay by the potential user for the possible use of natural environment in future.

Bequest value: it refers to an individual willingness to pay to preserved resource for future generation.

Existence value: it refers that the value which is individual is willing to pay for an environmental amenity even though individual received no direct benefit.

Aesthetic Value: it represents the value of scenic beauty even though no market transaction may occur to capture that value.

2.3. Contingent Valuation method

The direct method seeks to infer individual preferences for environmental quality directly, by asking them to state their preferences in terms of the environment. That means, they are asked to make a trade-off between environmental and other goods in a constructed market. There are two basic types of constructed markets i.e., hypothetical and experimental. The most commonly used, popular as well as debated method of hypothetical valuation is the contingent valuation method (CVM). In this section we discussed only about contingent valuation method.

The CVM was formulated by Davis in 1936 in his paper “Recreational Planning as an Economic Problem”. CVM is the oldest and most widely used but the controversial method of environmental valuation techniques. The contingent valuation method consists of asking

the people to express either their maximum willingness to pay for an increase in environmental quality or minimum willingness to accept compensation for a decrease in environmental quality.

CVM attempts to quantify the amount of income compensation required to leave the individuals level of utility unchanged that is, observations are generated around the surface of the total value curve to estimate this relationship empirically. In CVM we go for direct estimation of the marginal willingness to pay and then by aggregating these responses the total value curve is estimated.

Any CVM exercise can be broadly divided into five stages:

i. Formulation of the hypothetical market

ii. Obtaining the bids

iii. Average bids

iv. Estimating the bid curve

v. Aggregating data to estimate society's WTP/WTA.

Formulation of the hypothetical market

In any regular market for a commodity, the participation decision depends on (a) the exact knowledge about the quality of the goods, (b) the utility to be derived from the consumption of the goods and (c) the price to be paid to consume these goods. But, in the real world no market for environmental goods. But this good have demand and supply, so, here we talking about a hypothetical market. In order to construct a hypothetical market for 'α', information needs to be supplied on these three aspects. Here one has to show the respondent pictures of the existing state, pictures of the proposed state and the expected impact of this improvement. Finally, respondents should be convinced that the project cannot be undertaken unless some funds can be raised though nothing exactly is being changed at present. If proper awareness cannot be built up here, respondents will not have enough motivation to make payment commitments. The response is expected to be sensitive not only with respect to the magnitude of the required funds, but also the mode of payment vehicle. Suppose, the issue in question is up gradation of a recreational site. If general taxes are proposal to be imposed instead of charging entry fees, the respondents may state lower WTP because of the non-specific nature of the bid vehicle.

Obtaining the Bids:

At this stage the survey is administered. A face to face interview by well trained interviewers has turns out to be the most effective method of data collection. Individuals are asked to state their maximum WTP or minimum WTA for a proposed change in α. To quantify the precise amount truthfully, a number of alternative strategies can be applied. Generally, there are two types of obtaining bids-

i. Close ended bids (CEB)

ii. Open ended bids (OEB)

Close Ended Bids: a single payment P is suggested to which respondents either agrees or disagree. Such responses are known as dichotomous choice (DC) responses. If the response is Yes, then the investigator knows P≤ Max WTP, if No, then P≥ Max WTP, but no concrete information is available here to pin down the exact maximum WTP. In spite of this limitation this method is adopted quite often to avoid strategic bias in response.

Open Ended Bids: here the interviewer attempts to find out the exact maximum WTP. He adopts any of the three methods.

Bidding Gap: it start from a very low P and ask the interviewer whether he would pay this amount or not. If Yes, increase the bid and repeat this process until the first no comes. If No is the initial response then keep on lowering the bid until the first Yes comes.

Payment Card: Try to assess the average expenditure of a household with a similar socio-economic background on other publicly supplied goods and services.

Open Ended Question: Ask the respondent directly the maximum amount that he will be willing to pay for α, with no value being suggested to him. Respondent generally find it difficult to organize their reply.

Estimating average WTP/WTAC:

If open ended biding game or payment card approaches have been used, then the calculation of sample mean or median WTP or WTAC is straightforward. It is usual in CVM to find that mean WTP exceeds median WTP, since the former is influenced by a relatively small number of relatively high bids. If a dichotomous choice (DC) method has been used, then the calculation of average WTP/WTAC is more difficult, as we now explain.

In the DC framework, the researcher makes use of random utility theory. In particular, it is assumed that whilst the representative individual knows their own preferences, these are not completely observable by the researcher. In particular, it is assumed that the utility function of individual has

$U=U(Q_i, Y, X)$

Where, Q is the level of environmental quality

Y is income

X is socioeconomic characteristics, is only partly observable by the researcher. Suppose environmental quality improves from j=0 to j=1. The researcher acts as though the utility function is:

$V = (Q_i , Y, X) + \varepsilon_j$ .....(1)

Where, ε_j is an identically and randomly distributed error with zero mean. Suppose now that the individual is asked if they would pay an amount A for the environmental improvement . The probability that they will accept this offer is :

$P(Yes)= P [V (Q_1 , Y-A , X) + \varepsilon_1) \geq V (Q_0 , Y , X) + \varepsilon_0]$…….(2)

And the probability of saying 'No' is {1 – P (Yes)}. Equation (2) can be estimated statistically by first rewriting it as:

$P [\varepsilon_0 - \varepsilon_1] \leq [V (Q_1 , Y-A , X)] - V (Q_1 , Y-A , X)]$……(3)

Define ΔV as the change in the observable part of the utility function and n as $(\varepsilon_1 - \varepsilon_0)$ and f_n as the cumulative distribution function of the error. We can then write that:

$P[n \leq \Delta V] = f_n (\Delta V)$

Which , if $f_n (\Delta V)$ is assumed to have a logistic cumulative density function is equal to $(1 + e^{-\Delta V})^{-1}$. In order to proceed , a specific functional form for V must be adopted; V may be simplified into the form $V = (\alpha+\beta Y)$ with the change in utility determind by the change in this over the two states and the offer price A. suppressing X in this case we have:

$\Delta V = (\alpha_1 – \alpha_0) –\beta A$

Where the α and β terms will depend on X and the probability of a Yes response is

$P(Yes)= F_n [(\alpha_1 – \alpha_0) –\beta A]$

Alternatively, if $V = \alpha + \beta \log Y$; then the ΔV is roughly equal to $(\alpha_1 – \alpha_0) –\beta(A/Y)$.

Utility theoretically, WTP measure are calculated by Hanemann from these models. Let W be the true willingness to pay (WTP). W is distributed according to the function G_w, mean WTP is given by the integral:

Mean WTP $= \int_o^T [1- G_w] dA$ ……..(4)

Where, T is some upper limit, infinit for a true mean or some upper value for a truncated mean. Median WTP is given by:

$P [u (Q_1 , Y-W , X) \geq u (Q_0 , Y , X)]= 0.5$……(5)

In other words, the WTP value at which exactly half of the population would say 'no' which is that value of A to which exactly half the population would say Yes; since it is equal to or less than their true WTP. Hanemann gives formula for the calculation of these values from the models for V. as Duffield and Patterson point out, many CVM researchers use an alternative form for V. which, although does not give exact utility theoretic measures of compensating or equivalent. Surplus is thought to provide reasonable approximations. This involves specifying the probability that a respondent will say 'Yes' to the offer price A as:

$P\ [Yes] = [1 + e^{-\alpha-\beta \log A}]^{-1}$ ……(6)

Where, α term is the $(\alpha_1-\alpha_0)$ term above. This is the model that Bishop and Herberlin used and implies that WTP has a log-logistic distribution, which is everywhere positive and positively skewed. Median WTP can be calculated as Expected – (α/β): mean WTP must be evaluated by numerically integrating under the logistic function between specified upper and lower bounds.

Estimating Bid Curve:

Investigating the determinants of WTP/WTAC bids is useful is aggreagating results and for assessing the validity of the CVM exercise. A bid curve can be estimated for open-ended CVM formats using WTP/WTAC amounts as the dependent variable and a range of independent variables. For instance, in an open ended CVM survey, WTP bids might be regressed against income (Y), education (E) and age (A), as well as against some variable measuring the quantity of environmental quality being bid for (Q), if this varies across respondents:

$WTP_i = f\ (Y_i, E_i, A_i, Q_i)$

Aggregate Data

At the final stage the total WTP for the population as a whole is to be estimated. From our estimators of average WTP for the sample we have to infer about the average population WTP. If Y_i, E_i, A_i, and Q_i are replaced by their respective average population value, then the corresponding WTP_i would be the average population WTP (W_p). then (W_p * N) would give the total WTP for the society as a whole, where N is the population size.

There are many problems that have been identified with CVM:

1. Strategic bias: if the respondent presumes that the amount of money would actually be collected from him at some future date then with the intention of free riding he would

understate that this question is totally unrelated to his ability to pay then to enjoy higher moral satisfaction he would overstate his preference.

2. Hypothetical bias: another criticism of CVM is that the value is obtained in CVM surveys are not based on real income decisions- they are hypothetical. There is no budget constraint in a hypothetical survey and without a budget constraint choices are meaningless. This bias is identified as hypothetical bias.

3. Embedding Bias: Another problem with CVM is called embedding. The response is sensitive with respect to quality and not quality. People may place the same value on cleaning up one lake or ten lakes.

2.4. Hedonic Pricing

The hedonic price method starts with the assumption that as the environmental quality changes property prices would also change indicating the scope for estimating and implicit demand function for the environmental good by observing the property price variations. Hedonic price method depends on quality of changes and quality of environment. This approach is generally applied to the housing market, where the demand for housing is dependent on a number of characteristics that a particular site possesses. The price of a house is the written as:

$P_n = f (S_n , L_n , \alpha_n)$

Where, P_n = Price of the house

S_n = Space related factor

L_n = Location specific factor

α_n = Environmental factor

like any other market the transaction decisions in the housing market are also governed by the demand-supply interactions. Now, an attempt is made to present the theoretical framework in order to show how demand and supply function emerged in the market:

The consumer

Suppose a typical consumer has a utility function U and income is Y. The consumer purchases one house and the choice is only regarding the environmental attributes (α), as the available alternatives are identical with respect to all other characteristics. The consumer allocates income between the consumption of an ordinary good X and the housing, whose price P depend on α, i.e., P = P (α). The consumers problem is :

Max U (X, α) ; subject to X + P(α)=Y

Given the level of $U=U_0$, the question is what would be required amount to be spent on X consumption attain U_0 corresponding to alternative values of α ? let us define $(Y-X)=\Theta$, where Θ is the amount of income left to be spent on α. Obviously $\Theta= \Theta(Y,\alpha,U_0)$ which is called the bid function, as it represent the amount of money the consumer may bid for the house with characteristics α, to keep utility fixed at U_0, given his income level Y.

Since α is an exogenous variable, in order to enjoy better quality of α, one has to bid higher Θ. Thus, the bid function is upward rising. As more and more α would be available, for successive increases in α. The marginal willingness to pay will go down, which makes the bid curve concave shape. The bid function represents the total willingness to pay. This is shown in the following diagram:

The Producer

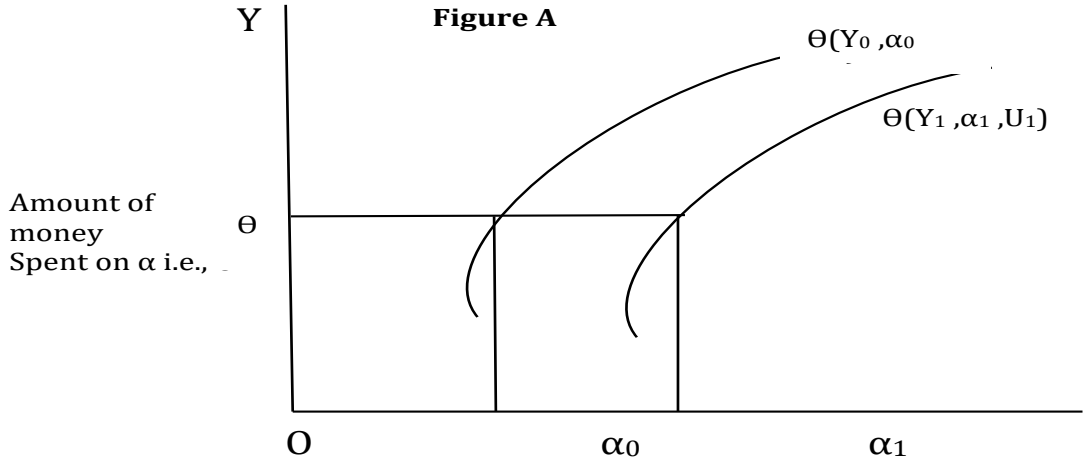
The supply side basically for the producer and supplier. The supply side of the housing market can be summarized in terms of offer curve. For the house with environmental quality α, the total production cost is a function of non land input prices (γ) and the land price is a function of α. Hence, the total cost is C=C (γ, α) . If the price offered by the producer is denoted by ϕ, then his profit from this sale would be vanish:

$\Pi \neq \phi - C(\gamma, \alpha)$. This ϕ will be represent by $\phi = \phi(\gamma, \alpha, \Pi)$,

Where, γ = Non land inputs price

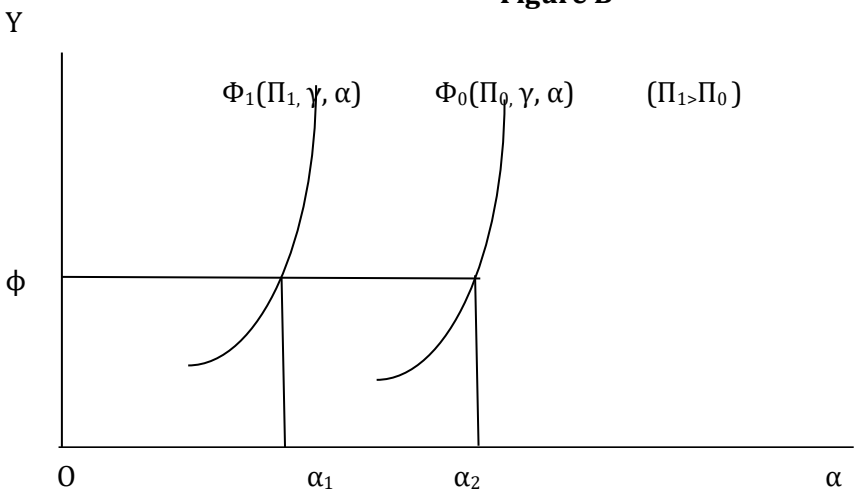
α = Environmental quality

Π = Profit



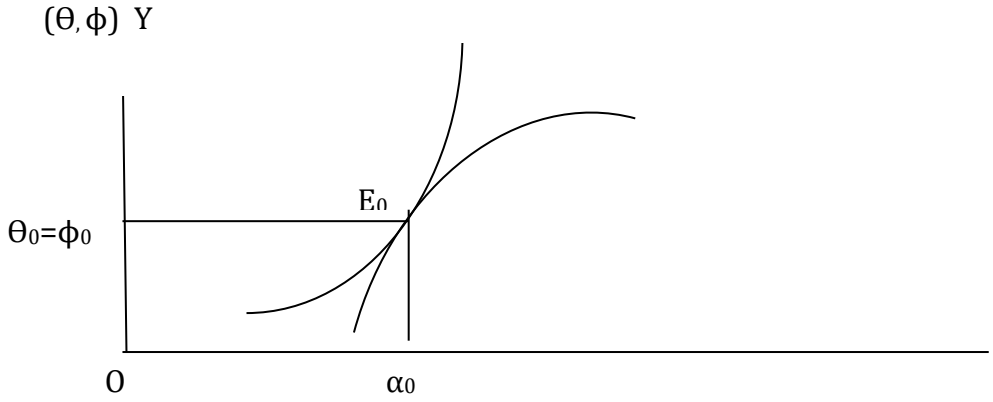
As more and more better quality of α can be purchased due to non-reproducible nature of environment, its relative scarcity would go up. Hence, the offer cup will be upward rising and will have a concave shape. We have shown in the following diagram:

Figure B



Now for any particular transaction to take place, the bid curve has to match the offer curve, where the bid curve has to match the offer curve, where the bid curve shows the consumer's willingness to pay (WTP) and the offer curve represent the producer's willingness to accept (WTA). For the transaction to take place the maximum WTP has to be greater than or equal to the minimum WTA. By superimposing Figure A and Figure B, we can show that the acceptable bid-offer match takes place at E_0 in Figure C, where the maximum WTP equals the minimum WTA in the margin , making the two relevant curves tangent to each other. So the house would be transacted at price $\Theta_0=\phi_0$ with environmental quality α_0.

Figure C



2.5. Travel Cost Method (TCM)

This method involves using travel cost as a proxy for the value of visiting outdoor recreational sites. A statistical relationship between observed visits and the cost of visiting is

derived and used as a surrogate demand curve. The travel cost method assumes complementarities between the environmental assets and consumption expenditure.

The simplest version of TCM involves collecting data on the total number of visits to a site from zone i, that is V_i and the total visitors population P_i of zone i. then (V_i/P_i) is proposed to be a function of the average travel cost C_i and other socio-economic characteristics $S_{i.}$. This C_i is the total travel cost which includes both direct expenditure during the trip and the imputed value of the time cost.

$$(V_i/P_i)= f(C_i ,S_i) = a_0 + a_1 C_i + a_2 S_i + W_i$$

Where , W_i is the random error term and i= 1,2,3,….k

K being the number of zones.

The estimated a_1 coefficient would quantify the change in the visitation rate following a change in the travel cost. So, a_1 is the estimated slope of the intercept of this demand function one needs data upto that level of C_i where visitors stop visiting the site altogether due to exorbitantly high cost. A few implications of TCM are interesting to note.

i. the representative visitors utility function is assumed to be seperable, at least in the recreational activity being modeled. If the activity of interest is visiting a national park , the willingness to pay (WTP) for the trip can be estimated independent of his WTP for everything else.

ii. when the representatives visitors decides not to undertake the trip because of the high expenditure involved in the decision then the marginal social cost of future environmental degradation will not have any influence on the implicit demand function. The negative WTP is not observable. This features makes travel cost method inappropriate to capture non-user values. It can only quantify the user-value of the environmental amenity.

iii. for a proper estimation of the amenity demand function one needs to collect information from households that have made a visit as well as those who did not take up a trip to this particular site. If the information on the second group is not collected, the empirical estimates would be subjected to a truncation bias. Because of this partial observability one has to run a Tobit regression instead of a regular one.

iv. in demand estimation through travel cost method, problems arise with multipurpose trips. It may be necessary to make a distinction between meanders and purposeful visitors. For those who are visiting different sites on a single trip. Only a part of their total travel cost is to be attributed to a particular site visit. The proper specification of the apportionment rule for this common cost is a methodological challenge.

v. on many occasions, environmentalist and policy makers are more interested in the value of changing the characteristics of a site rather than in the value of the site in toto. Here the demand equations for different sites have to be estimated and the sensitivity of the regression coefficients with respect to the site characteristics is to be studied. This sensitivity analysis would quantify the marginal WTP. Two alternative techniques applied for this purpose are the varying parameter models and the dummy variable technique.

vi. when the visitors selects a particular site from a number of alternatives then one can suggest a modified version of travel cost method to incorporate this discrete choice. Here, the Random utility model is generally applied where the utility from the visit to a recreational site is assumed to be composed of an observable deterministic component and the random error term. Here the sole purpose of the quantitative analysis is to find out the probability of visiting a particular site, given the relevant information. If we assume the probability to be totally explained in terms of relative site characteristics, we apply conditional logit. When besides relative site attributes, these probabilities are made contingent upon the personal characteristics of the individual taking the decision and then the relevant quantitative technique would be the multinomial logit.

2.6. Questions

i. Discuss the use and non-use value.

ii. Discuss the various steps of contingent valuation method.

iii. Explain the Hedoric pricing of environmental goods.

iv. Discuss the travel cost method.

UNIT III
ENVIRONEMNT AND DEVELOPMENT

Structure

3.1. Introduction

This unit deals with the relationship between environments and development. The environment is very important to economy. However, there has been rapid degradation of environment with the passage of time. There are various reasons for environmental degradation. One of the main reasons for degradation of environment is the economic development. The increase in the level of economic development requires extraction of more

and more resources from the environment. At the same time, the increase in economic activities of production and consumption due to economic development increases the amount of waste and pollutants which are ultimately disposed-off in the environment. In this background this unit attempts to examine the trade-off between environment and development, impact of trade on environment, substainable development and green accounting.

3.2. Objective

The objective of this unit is to impart the knowledge about the importance of environments to the economy and to understand the relationship between environment and development. The rapid economic growth over the last decades coupled with population growth has put huge pressure on environment. As a result, there has been significant degradation of the environment throughout the world. Hence, the need for promoting sustainable development has assumed greater importance.

3.3. Environment and Development trade-off

The environment and economy are closely interlinked. The environment provides raw materials and other resources to the economy. The economy transforms those raw materials derived from the nature into consumable goods. However, along with production of goods, the producers also generate wastes and pollutants which are ultimately disposed into the environment. The environment also acts as a sink of wastes pollutants. But it has a limited capacity of waste assimilation as there are some wastes or pollutants which cannot be degraded easily. The environment also provides amenity and global life support services.

In the pre-industrial period, there was a very little or no environmental problem. However, after the industrial revolution, there has been rapid economic development and at the same time the environmental quality started to deteriorate. Hence, the question of environment and development came to occupy an important place. This question relate to relationship between environment and development. Since economy derives resources from the environment and disposes waste into the environment, the economic development is likely to put pressure on environment and cause its degradation. However, the recycling of waste can reduce the flow of resources from the environment into economy reduce pressure on environment. At the same time, the development of new technology can ensure higher

efficiency of use of energy like fossil fuel and reduce pressure. The progress in science and technology can optimize resource use and ensure sustainable development.

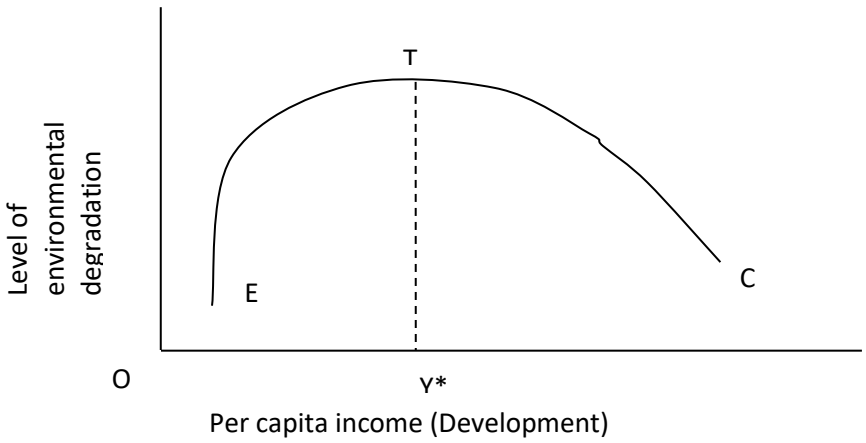
Thus, the nexus between environment and development is quite complex. The question of how are they related to each other is similar to the one posed by Simon Kuznets in 1955, regarding the level of income and inequality along the state of economic development. Kuznets hypothesized that there is an inverted U-shaped relationship between inequality and development. That is due to the income inequality increases initially along the path of development but it reduces at the higher stage of development.

The environment and development trade-off can also be explained in terms of Environment Kuzets curve. This discussed as follows;

3.3.1. Environmental Kuznets Curve (EKC)

The Environmental Kuznets curve relationship between environment and development takes its inspirations from the income distribution theory developed by Simon Kuznets in 1955. In his study, Kuznets found an inverted U-shaped relationship between the indicators of income inequality and the level development as measured by per capita income. The income inequality increases along the path of economic development in the early phase, declares in the later phase.

Gene Grossman and Alan Krueger in their studies of the relationship between the environment degradation and economic development found a similar inverted U-shaped relationship. This inverted U-shaped relationship between the environmental degradation and economic development is known as Environmental Kuznets Curve (EKC). The EKC hypothesis expresses the most likely relationship between the environment and economic development. It states that the environmental degradation is low when the level of economic development is low. The environmental degradation increases with economic development in the early phase but it comes down at the later stage of development. That is, in the initial stage of development, environmental degradation increases but eventually declines at certain threshold level of income.



In the figure EC is the environmental Kuznets curve which is inverted U-shaped. The level of environmental degradation is measured along the vertical axis and the level of per capita income (a measure of development) is measured along the horizontal axis. The curve shows that as the level of income increases, the environmental degradation also increases but up to point T. T is the turning point and Y* is the threshold level of income at which the turning point occurs. As the level of income increase further the level of environmental degradation starts to decline as indicated by the downward sloping portion of the EC curve beyond the point T.

The explanation for the invested U-shaped relationship between the environmental degradation and the level of development are as follows:

The increase in environmental degradation in the initial phase can be attributed to the heavy emphasis on economic growth and capital formation to enhance production and consumption. It is due to heavy emphasis on industrial development and movement of the economy from the clean agrarian economy to polluting industrial economy. For the early phase of development, people tend to neglect environmental matters due to high level of poverty, lack of awareness, income inequality and lack of community level institutions etc. These result in increase in environmental degradation in the early phase of development.

The decline in environmental degradation after the certain threshold level of income is attributable to technological change and efficiency in use of energy and other resources. The technical innovation enables the economy to produce more level of output with the same resources. At the same time, it encourages the recycle of materials and reduces the pressure on the environment. Further, the institutions of natural resources by resources not linked to environment, increase in education and awareness among the people about the ill effects of environmental degradation and better implementation of environmental regulations contribute to reduce environmental degradation. In fact the person to with higher income has a tendency

to prefer better environmental quality and spend more to consume the environment. The economic structure also changes from polluting industrial to clean services economy.

3.3.2 Criticisms

The EKC relationship between the environmental degradation and the level of development has been criticized under the following grounds:

(1) The Environmental Kuznets curve has been found only for some air quality indicators especially local pollutants. There is no evidence of the EKC in case of global pollutant like carbon dioxide (CO_2).

(2) The EKC hypothesis states that at certain threshold level of per capital income the turning point will occur and increase in income beyond that level heads decline in environmental degradation. However, it does not say the exact level of income at which the turning will occur. There is no agreement in literature on the income level at which the environmental degradation starts declining.

(3) The shape of the curve may be N-shaped instead of invented U-Shaped if the level of environmental degradation after declining for some time again starts increasing as nations incomes continue to increase. Arrow argues that the inverted U-shaped relationship would appear to be false, if pollution increases again at the end due to higher levels of income and mass consumption.

(4) Suri and Chapman urged that met reduction in pollution may not be occurring. On a global scale because the wealthy nations have a tendency of exporting the pollution intensive activities like, manufacturing of clothing, furniture etc. to poorer countries. Thus, the level of pollution may be declining in the developed countries but it is compensated by the increase in pollution in developing countries. So, the pollution level at the global scale may remain unchanged with economic development.

Thus, it can be concluded that the relationship between the environment and economic development is quite complex and unpredictable. The environmental Kuznets curve has tried to explain the possible relationship between the level of environmental degradation and economic development. The hypothesis populated that in the early phase of development, environmental degradation increases. But as the level of development reaches certain threshold the people become aware about the

environment and invest more in environmental protection. This leads to decline in environmental degradation.

3.4. Population, Poverty and Environment

Human population has grown at an accelerated rate in the two centuries – at the advent of industrial revolution. During the same period development in medicine and health care as a result of advances in science and technology contributed to substantive reduction in death rate – leading to high growth of population was around 0.5 billion and was growing at the rate of 0.3% per annum. By 1970 world population became 3.6 billion and with a growth rate of 2.1% per annum world population rose to 5.4 billion in 1991 and fall in growth rate to 1.7% per annum. This was done to fall in global birth rate which were falling since the middle of 20^{th} century, but it was falling shown than the death rate. The world population has reached 7 billion in 2010. The current (2019) world population is 7.7 billion.

Thus there has been increasing pressure of population growth and human activities on the limited resources of the biosphere.

With growth of population –density, the natural resources to human population ratio goes down, straining the life support system of humans and resource supply to their economy.

Human population creates demand on environment in two ways –
First, like all other species, human population depends on nature for life support services – like oxygen, water, and some natural foods. Second, unlike other species, human beings transform through production process, materials and energy drawn from nature into consumable goods and services. The size of an economy where growth would cause strain and pressure on the nature has two aspects returning consideration:

a) Size in terms of population
b) Size in terms of GDP.

These two factors have interactive relationship.

Capital accumulation and development of an economy influences the process of demographic transition and the growth of population.

On the other hand, the growth of population in an economy would have scale, composition and technology of the economy depending among others on the local natural resources base.

Every society and economy adapt to the population pressure. The institutions evolve arrangements to accommodate the needs of the growing population while attempting at the same time to control population growth through policies. The ecological and economic effects of population growth would have a feed back on population growth itself. The demographic, technological, economic, ecological and cultural factors of a society influence each other in a web-like manner. The mechanism of their interaction is quite complex and it is difficult, if not impossible, to strictly separate the partial effects of variation of population and that of GDP as pure scale factors on the nature and environmental quality. However, the interaction of the complex factors is likely to exert a regulating influence on population growth so that it does not violate the carrying capacity.

There is no definite law of behavior of the socio-economic system which would guarantee that carrying capacity limits are not violated by human population growth. The success of the society in regulating population growth and not violating sustainable use of resource use would depend on the extent of success in revolving the distribution problem which is attend and with growing population.

The extent of success has often been far less than the sustainability mark in countries of high population density in Afro-Asian region. If the economy can absorb the growing labour force in effective employment, it can mitigate the problem of poverty an environmental degradation. But if the population growth leads to growing unemployment than poverty will size in number of poor without income and property rights to well defined resource endowment. The availability of land per capita falls within increase in population, leading to fragmentation of land holdings leading to less productivity and dispossession of land due to cash need of families to meet basic necessities. The landless people would join landless labour and class in the rural system or migrate to urban area to join urban labour force. In other case, the poor in developing countries resorts to forest burning or forcible occupation of open access common property land and its conversion into cropland, leading to ecological balance in land use. This causes deforestation and farming on hill areas cause soil erosion and flooding.

However, even if the rural poor farmers are able to practice agriculture, they often over use the land for cultivation by unsustainable agriculture practices such as mono-cropping and shifting cultivation. Over population and poverty do not pursuit investment in

land and results in its degradation and unsustainable agriculture practices in many Afro-Asian countries.

Besides, the fuel need of the poor has been met from trees or plants from forests causing deforestation.

The rural-urban migration of the poor in over populated economic system has led to unauthorized occupation and use of land. The density of population in such unauthorized settlements of urban areas is very high with inadequate access to water and almost no access to sanitation. This heads to serious problem of water population and health problem. Urban slaves with high population density and paved surface poses serious problems of an collected unabsorbed wastes. Thus, urban system forces problems of serious population due to lack of adequate water supply, sanitation and waste disposal.

Thus, population growth with growing poverty, leads to appropriation of natural resources of land, water and forest which are open access. Such resources are inevitably overused leading to either depletion or degradation.

The poor would operate outside market system and consume natural resources directly for survival by over harvesting natural resources. Thus, the growth of population with observing of the distribution problem has reduces further. The resource to mass ratio through not only rises in denominator but also fall in the value of numerator. This decline in ratio reduces carrying capacity of nature and biological limits to growth and aggregates the problem of sustainable development.

Since the population grows in and poverty adversely affects the environment, the policy should be designed to check population growth and reduce poverty.

3.5. Trade and Environment

The relationship between trade and the environment is quite complex and has been a matter of concern for economists. The concern relates to how expansion of trade impacts on the local as well as global environmental conditions. The issue has gained greater importance in the context of liberalisation of trade and shift in trade policy across the world from inward looking to an outward looking approach based on export promotion driven by the market forces. In the changing situation, the volume of trade among the countries is expected increase significantly. The increase volume of trade is likely to increase the demand for environmental goods and increase in waste and pollutants due to increase in production and consumption. Hence, the question of trade and the environment has come to occupy the fore

front seat as to how the expansion of trade affects the environment. Therefore, the need to study the implication of the new world order on the environment is increasingly being felt.

Before going to the discussion on the effect of trade on environment, let us consider the basis for international trade. The basis for international trade is the existence of a price differential. Two countries can engage ina mutually beneficial trade if the price of a commodity differs in them under autarchy. The reasons for prime difference are the comparative advantage. According to Ricardo, trade between the two countries occurs due to comparative advantage. A country is said to have comparative advantage in production of a good if the relative price of that good is lower under autarchy compared to other country. A lower relative price of good 1 means a lower relative cost of producing good 1. The relative cost is the cost of producing good 1 in terms of goods 2. Thus, a country is said to have comparative advantage in good 1, if it can produce good 1 at lower relative costs. According to trade theories the causes of a difference in relative costs between two countries are (i) labour productivity and (ii) The relative availability of factor endowment.

The Ricardian model locates the source of comparative advantage in labour productivity. A country has comparative advantage in some goods because its labour is relatively more productive in that line of production compared to other country. This makes the relative cost of producing that good lower.

Given two goods, 1 and 2 which are produced with the help of a single factor labour. Hence country has a comparative advantage in good 1, if

$AL_1/AL_2 < AL^*_1/AL^*_2$

Where $AL_1$and AL_2 are the amount of labour needed to produce good 1 and good 2 in home country and AL^*_1 and AL^*_2 are the amount of labour needed to produce good 1 and good 2 in foreign country. The ratio shows that relative of cost of producing good 1 is lower in home country. Thus, if trade opens up, home country will export good 1 and import good 2.

When the trade opens up, the home country will specialize in production of good 1 and foreign country will specialize in production of good 2. The volume of trade as well as production of two goods expands and both the countries obtain higher output and higher level of welfare. Thus, both the countries gain from trade due to comparative advantage arising out of differences in labour productivity.

However, in the context of trade and the environment, this comparative advantage can be artificially created. This is particularly in the case of the North-south trade relation. Here the North refers to developed countries and the south to underdeveloped countries. The

North-south trade relations have traditionally been characterized in terms of asymmetry with the pre-industrial south exporting primary products and the North exporting industrial products. However, in the last four decades the nature of the North-South trade has changed significantly with several countries in the south having considerable degree of industrialization, industrial products now constitute a good share in the exports of south. This does not imply that the Souths have achieved true comparative advantage in industrial products. Its comparative advantage may be artificially created by the North so as to shift the polluting industry to the south with a motive to protect their environment.

The impact of trade on environment in the context of the North-south trade relations can be explained with the help of externality, market failure and the environment.

3.5.1 Externality, market failure and the environment

Sometimes there are cost associated with an economic activities that are borne by the population at large but do not appear in the calculations of the producer. Similarly, there might be benefits according to the society that the producer's fails to capture these are the cases of externality. In the presence of externality there is a divergence between private and social costs and benefits.

It is this divergence between private and social costs that provides entry point to the question of environment and allow us to analyze its relationship with international trade. The Environment is just like open access/common property resources – water, air, forests, plants, biodiversity etc.

All waster products of economic activities are dumped in the environment. The damage does cause to environment in the form of air pollution, water and destruction of plants and biological species are important costs in society as a whole has to bear.

These costs do not appear in the cost calculation of the producer (external cost) and thus remains unconvinced. This is a case of market failure which has implications of international trade.

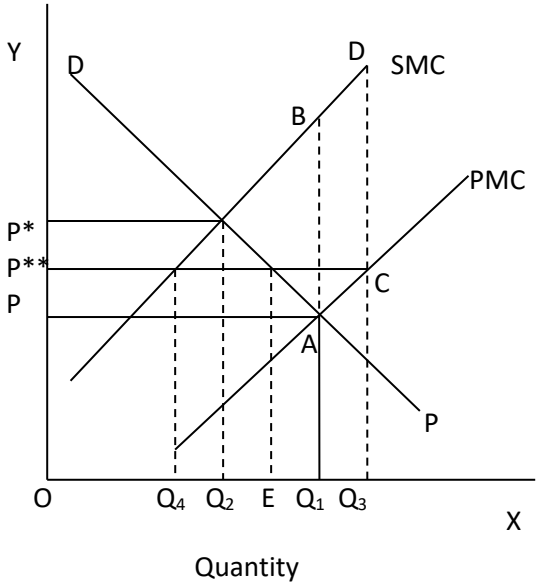
The negative impact of trade on environment might be local as well as global. Increase in economic activities due to trade may pollute and degrade the environment of a particular country or may have global impact. Population of good causes pollution, marking the social cost and marginal private cost.

We locate the difference between North and South in terms of presence or absence of environment regulations stringent regulation forces producers to set prices at level equal to social costs. But such regulations are absent in the South. This is because people in North are more aware about the ill effects of environmental degradation. The North have higher hence of income and so preference for better quality of environment fresh air, clean water and green surroundings.

Assuming the same technology in the two region autarchy prices will be different P price in South and P* price in North. Note that absence of environmental regulations result in the production of larger quantity of the polluting good in the South.

The South enjoys a comparative advantage although the advantage is at the expenses of the environment.

As trade opens ups, arbitrage begins and the South exports the goods to North. The final free trade equilibrium price settles somewhere in between the two autarchy prices and this price is P**. P**>P. This induces south to expand production up to Q_3. Thus, trade leads the South to specialize in the dirty good. The gap between social and private cast also increases as a result of trade from AB to CD. The flip side is that North produces less goods at home OQU but consumes more of them (OE instead of OQ_2) as they are cheaper in the trade situation P**<P*. Import QUE from the South. Thus, trade induces the South to expand production of the dirty goods and causes environmental damage to meet the Northern consumption needs and North can consume the good without having the damage its own environment.



The price of the North pays for the goods in the trade situation is less than its social cost of production. That is a part of the social cost that is not paid for by the North is borne by the South.

Thus, during the course of industrialization developing countries are inclined towards industrial activities that are pollution intensive in which they do not traditionally have comparative advantage. It is argued that increasing production costs of dirty goods in developed countries due to increased demand for clean environment from consumers and increased regulations, and loose regulation and less concern for environment in developing countries on the other hand, cause dirty industries to migrate from developed to developing countries. This is so called pollution haven hypothesis which argues that dirty industries flee from environmentally strict industrialized countries to less developed countries which provides pollution havens for those industries with their less environmental standards. The share of dirty industries is exported to increase while that of clean industries to decline over time in pollution heavens. Also, since, pollution havens becoming large producers of the dirty industries, the share of dirty industries is imported to increase in the exports of goods a pollution haven.

Thus, the difference in environmental regulations can serve as a basis of comparative advantage for the South and the expansion of trade based on such artificial comparative advantage can be detrimental to the environment in the South (developing countries).

3.6 Concept of Sustainable Development

Concept came into being in 1987, in view of environment degradation due to over exploitation of resources to achieve higher economic growth. So, development must take into account the interest not only of present but also of the future generation.

The concept of sustainable development concerns to fulfill the needs of the present generation without affecting the interest of the future generation. It aims at inter-generational equity.

One of the widely accepted definitions is from the report of the world commission on environment and development (WCED) in 1987.

Sustainable development is development that meets the needs of the present generation without compromising the ability of future generation to meet their own needs. It is concerned with the welfare of the future as much as the present generation.

In essence sustainable development is a process of changes in which exploitation of resources. The direction of investments, the orientation of technological development and institutional changes are all in harmony and enhance both current and future potential to meet demand needs and aspirations. Thus, sustainable development is process of economic

activities which leaves the environmental quality level intact with the policy directives corresponding to this notion being the maximization of net benefits of economic development for the present and future generation subject to maintaining the services and quality of natural resources over time.

It tries to combine efficiency with all other attributes to sustainability preserving opportunities for future generation is a common sense minimal notice of intergeneration justice. It says that the present generation does not have the right to deplete the opportunities offered by the current resource base since it does not own it.

Development = efficiency + equity

Sustainable Development = Development + proper valuation + resource stock recognition + resistance.

3.7 Indicators of sustainable Development

Sustainability refers to both ecological and economic attributes. Therefore, corresponding sustainability indictors will also have to account for both of them.

There are two types of sustainability

1. Strong sustainability and
2. Weak sustainability

The strong sustainability concept concentrates on the impact of development effort as ecology and environment. On the other hand, weak sustainability concentrates on green accounting which involves accounting of national income taking into account the ecological effect of development.

The main point of difference between the two is that former denies greater or lesser extent substitutability between natural assets and manmade assets and others.

3.7.1 Indictors of strong sustainability

The strong sustainability paradigm distortindicator that focus primarily on ecological aspects, functions and processes in them such indicators find to stress limits to the deterioration of ecological assets.

Indictors are –

1. **Carrying capacity –** The notion of carrying capacity is drawn from biology. It states that a given environment/area can sustain only a given population of a particular species and at this upper limit (carrying capacity) population would have reached

maximum sustainable level. In order to apply this concept of a saturation point to human population, we have to consider not only the level of population, but also the level of economic activities. For sustainability of the system, the carrying capacity should be extended.

2. **Resilience –** It refers to the ability of the system to absorb shocks and changes and still persist the degree of resistance of the system determines whether ecological process in largely unaffected, decrease, either temporary or permanently or in the extreme collapse all together. Because of risk and uncertainty in the production process. It was realized only recently due to development of thermodynamics theory that processes involving higher and higher levels of energy production and consumption also generates higher levels of waste.

   This is known as the entropy law in physics. Example, more electric production means more production of fly ash, SO_2 and CO_2 and NO_2 if fuel oil is the source (coal). Waste disposal is not cost free. Waste is on externality when no one wants to take the responsibility of disposing it. The biosphere has some capacity to assimilate waste however slow it may be out enhance waste assimilation requires additional investment on treatment plants on incineration plants. A measure of the degree of resistance could be interpreted as an indicator of the sustainability. For agriculture dependent system an indicator of field variability may also be relevant in measuring resistance.
3. **Distance to goal –** Under it the derivation of ambient assuming from some target are aggregated to derive an overall performance indicators.

3.7.2 Weak sustainability indicators

The weak sustainability on the other hand, emphasizes, the sustainability of manufactured and natural assets and hence focuses on aggregate measures like –

1. **Green GNP (green accounting of National Income)**

   The concept of green accounting of NNP arises from a concern that an economic indicator such as NNP doesn't reflect the depreciation and degradation of environment. This may lead to incorrect development divisibility. Green national income accounting takes into consideration the environmental and ecological loss arising out of the developmental effort while calculating the national income. Green national income is environmentally sustainable income of the economy.

A sustainable path has the characteristic that along it the overall productive capacity is not reduced, what we need to know is at each movement how much of this productive base we can use up. This is given by environmentally adjusted NNP. NNP is the total income earned by the economy less allowances for the depreciation of man-made capital.

ENP = GNP –Depreciation of man-made capital-depreciation of natural capital.

ENP is a good measure of sustainable development.

Environmentally adjusted NNP(ENP) is the annual pay-off from our total capital stock (Man-made and natural)

ENP will rise if the total capital rises or as technology improves. So the indicator of sustainable development is whether the ENP is rising or falling. The development to sustainable if the ENP is rising and vice-versa.

2. **Genuine savings**: Genuine savings is the national savings adjusted for the loss of assets to achieve sustainability. It is more promising offshoot of green accounting. For sustainability, genuine saving rate must not be persistently negative. Sustainable development requires the maintenance of total capital stock. Since the national savings are invested in physical capital, saving rate which is at least as great as the combined depreciation of natural and manmade capital help in maintaining the stock of total capital and ensure sustainable development.

3.8. Rules to sustainability

The following rules have been developed to achieve sustainability.

1. the Hartwick – Solow approach
2. Non-declining natural capital stock approach
3. The safe minimum standards approach
4. Daly’s operational principles

These rules to sustainability are discussed in details as follows:

3.8.1 The Hartwick-Solow approach

John Hartwick in 1977 proposed a rule for ensuring non-declining consumption through time in case where an economy made use of non-renewable resources like oil in its economic progress.

This rule is based on the assumption that manmade and natural capitals are perfect substitutes of each other. Further, it assumes that the aggregate production function is a Cobb-Douglas one.

Given these assumption, the rule states that as long as the stock of capital did not decline overtime, non-declining consumption was possible. According to Hartwick, the stock of capital can be held constant by reinvesting all the hotelling rents from the extraction of non-renewable resources in manmade capital. When the capital stock is held constant, then non-declining consumption is possible and such a development process is sustainable, according to Hartwick. Thus as the stock of natural capital goes down, the stock of manmade capital is built up in replacement. This result has been very important for achieving of sustainable development.

The Hartwick rule has been criticized on three points.

1. The non-declining consumption is not the same as non-declining welfare. This is because individuals derive utility directly from the environment. So, when the natural capital goes down. The utility also goes down and the people's welfare will be lower even if the consumption remains the same.
2. The rule depends on the particular functional form chosen for the aggregate production function and does not hold good for other functional forms.
3. Natural and manmade capital are not perfect substitutes.

3.8.2 Non-declining natural capital stock approach

The deficiency in Hartwick rule is partially rectified by a rule designed by a group of economists from London School of Economics – (Pearce, Atkinton and Thorner). This rule states that many elements of National Capital K_n provide non-sustainable services to the economy. Examples of such critical natural capital are the processes responsible for regulation of atmospheric compositions the spiritual values provided by wildlife, and nutrients cycles. It is important to maintain these ecosystems in a functioning state. This rule states that the society should identify all such critical non-substitutable natural resources and

must resolve to preserve them. This is commonly known as holding natural capital constant, as a concept, but as a rule to be applied for critical natural resources.

Thus, if it is necessary to maintain some amount of the natural capital stock constant in order to all future generations to reach the same level of utility as the average hold by this generation, this holding constant of the natural capital stock becomes a rule for sustainable development (SD).

This rule assumes that the value of K_n can be measured at any point of time; in other words, the different elements of K_n can be aggregated together in comparable units. In reality it is very difficult to aggregate the K_n. – Van Pelt (1993) identifies another problem with this rule. This is that the problem of spatial aggregation; within which geographic area should we hold K_n stocks and constant?

3.8.3. The safe minimum standard approach

This rule was proposed by Ciriacy-Wantrup and Bishop. It is closely linked to non-declining natural capital approach. The SMS approach originates from decision making under uncertainty. Society is deserved to be immense about the future costs of current environmental degradation.

The SMS rule is to prevent the reductions in the natural capital stock below the safe minimum standard identified for each component of this stock. Unless the social opportunity costs of saving so are unacceptably large. But it is a matter of moral and social obligation to define such standards.

The problem with this approach is how to identify these SMS levels. Another problem is with measuring of opportunity cost of conservation. It does not consider the economic benefits of conservation;

3.8.4 Daly's Operational Principles

Daly in 1990 developed operational principles for SD. He argued that a nation could move towards a SD position if these principles were followed. These principles are –

1. Renewable resources (like fish, forests) should be harvested at levels at less than or equal to the population size.

2. Pollution – For degradable establish assimilative capacities for receiving ecosystems and maintain waste discharges below this level. Daly proposes no rule for cumulative pollutants, but the implicit – is that their discharge should be set to zero.
3. Non – renewable resources –Receipts from non-renewable extraction should be divided into an income stream and an investment stream, the investment stream should be invested in renewable substitutes (For ex-biomass for oil) such that, by the time period when the non-renewable resources reaches the end of its economic extraction, an identical level of consumption is available from the renewable substitute.
4. Daly believes that it is vital to minimize throughout in the economy. This is a question levels and resources use.

3.9. Concept of Green Accounting

The Net National Product (NNP) is still the best welfare measure under standard national income accounting. But the present system of national accounting i.e. NNP fails as a measure of sustainable development as it does not take into account the use an abuse of natural resources. While considering the allowances for consumption of capital in calculating NNP, it gives consideration only to depreciation of men-made capital and ignores depreciation of natural resources – non-renewable, renewable resources, pollution etc.

The present SNA suffers from certain deficiencies. These are:

i. The SNA takes note of only such production and consumption processes where there is market price.
ii. It does not impute the values of environmental goods and services used in production process and
iii. It also does not consider any allowance for depreciation/degradation or depletion of natural resources.

The Green accounting of income is an attempt or method to correct the present measure of NNP for use and above of natural and ecological resources to arrive at sustainable income which can be a measure or indicator of sustainable development.

The improvement in the methods of SNA were debated in the 1992 United Nations conference on Environment and development (UNCED) held at Rio de Jenerio, which recommended all nations to develop a system of Integrated Environmental and Economic. Accounting (IEEA)- which came to be known as Green accounting.

The main objective of IEEA is to expand existing system of national economic accounts in order to integrate environment and social dimensions in the accounting framework. Alternatively, at least satellite systems of accounts for natural resources be developed to arrive at what is currently being coined as 'Green GNP.'

In practice, it is difficult to develop an accounting for natural resources.

Parikh and Parikh (1997) elaborated on the system of Environment and Economic accounting as developed by the United Nations and provided a definition of Green NNP as – Green NNP = Value of consumption of natural goods and services + value of production of natural collected (such as fuelwood, biogas) + value of environmental amenities provided by environmental resources stocks (such as clean air, top soil) + value of leisure enjoyed (Say in enjoying aesthetic beauty of wildlife revenue) + value of net additions to production of capital + value of net addition to natural capital stock + value of addition to stocks of defensive capital (such) as water purifier).

Thus, NNP is the total income earned by the economy in any year, less an allowance for the depreciation of manmade capital.

Green NNP or environmentally adjusted NNP is a good measure of sustainable development as it induces – (i) all elements of NNP correctly valued in terms of current economic situation; (ii) when this is true in a forward looking sense too (prices reflect future scarcity) and (iii) when all depreciation of natural capital is similarly allowed for as well.

Thus, Green NNP is the annual pay-off from our total capital stock (manmade + natural). ENP can rise over time if this total capital stock rises and /or as technology improves. According, Hartwick rule, the total stock of capital can be maintained by reinvesting hotelling rents (price-MC) from optimal non-renewable resourcesinfraction planning new natural or manmade capita. So, the indictor of sustainability is non-declining ENP, or whether ENP is rising or falling. It ENP is falling, and then society's sustainable level of income is falling too. Development is unsustainable.

3.10 Let us Sum Up

This unit discussed about the relationship between the environment and development in the light of Kuznets curve hypothesis which argued that there is an inverted U-shaped relationship between the two. It also analysed and discussed how the expansion of trade can affect the environment, particularly of developing countries. Sustainable development has come to occupy an important place in literature and policy making process. The unit also

discussed the concept and indicators of sustainable development and rules to sustainability. Finally, it also examined the measure of sustainable income i.e. green accounting.

3.11. Key terms

Environmental goods: These are those goods which are provided to the economy by the environment. They are non-excludable but rival in nature.

Environmental degradation: It refers to the deterioration in the quality of environmental amenities such as air, water, land etc. due to human activities.

Biosphere: It is the layer of the earth where life exists.

Carrying capacity: It is the capacity of a given environment to support the maximum number of population of a given species.

Sustainability: It is the ability of a system to maintain the resources and avoid depletion of natural resources in order to maintain ecological balance.

3.12. Questions

1. Analyse the relationship between the environment and development.
2. How does trade affect the environment? Discuss.
3. Explain the linkages between population poverty and environment.
4. What is sustainable development? What are its indicators?
5. Discuss the various rules to sustainability
6. Explain the concept of green accounting.

3.13 Further/Suggested Readings

Bhattacharya, R. N., *Environmental Economic: An Indian Perspective*, Oxford.

Hanley, N, J. Shogren and Ben White; *Environmental Economics: In Theory and Practice*, Macmillan Publication.

Unit IV
POPULATION GROWTH AND FERTILITY

Structure

4.0 Introduction

Population growth is often said to be one of the main factors behind India's backwardness. India is clearly one of the most densely populated countries in the world. India's population has trebled since independence. It seems to be heading towards 1.5 billion by the middle of the twenty-first century. For any student of demography, it is important to have a clear understanding of the size and growth of India's population, the reasons for the changes in growth rates of population and the factors determines its growth.

4.1 Objectives

After going through the chapter you should be in a position to answer the following questions:

- What has been the trend in population growth of India?
- What are the difference between Rates and Ratios.
- What are the various sources of data in Demography?
- Understanding the factors determining the fertility rate of a country. What are the reasons underlying the continuing high fertility rate in few States of India?
- Describe the economic theory of fertility as formulated by Garry S. Becker.
- Show how economic and non-economic factors are combined together to explain fertility behaviour by Richard Easterlin.

4.2 Trends of population growth since the beginning of 20th Century

The population of India is the second largest in the world next only to China. About 17 per cent of the world's population reside in India, where as it accounts for only 2.42 per cent of the total world area. If availability of demographic data is an indicator of development, then India is above many underdeveloped countries of the world where paucity of demographic data still poses a serious concern for systematic demographic analysis. The size of population of India presents a history of erratic growth. It was from 1881 onwards that Census was conducted every ten years in the country. Data from 1901 onwards are considered to be more reliable. The size of Indian population decreased between 300 B.C. and 1600 A.D and similar decreases could be seen during the decades of 1871-1881, 1891-1901 and 1911-1921. The decline of population during the interval 1911-1921 is mainly attributed to the influenza epidemic of 1918 in which according to one estimate more than 15 million persons were killed.

According to the 2011 Census, India's population of 1210 million shows 17.6 percent decennial growth between 2001-2011 resulting in absolute increase in population of 183 million over the 2001 census population. The total population consists of 623.7 million males and 586.5 million females indicating a sex ratio of 940 according to the 2011 census. Though, there has been a marginal decline in growth rate of population from 1.93 per cent during

1991-2001 to 1.51 per cent during the decade 2001-2011, yet the growth rate of population continues to be quite high in comparison to other countries of Europe and North America. The high rate of population growth in India with its large size of population has some advantages as well as disadvantage from the economic and social point of view. At the macro level it provides a large and growing labour force as well as a large market for goods and services. On the other hand, in an agrarian country with low savings and low capital formation, investment generation poses serious problems.

The population growth of India can be subdivided into four distinct periods. The first twenty years of the century from 1901 to 1921 witnessed a net addition of only 5.4 per cent, or 12.9 million persons to India's population, the next thirty years from 1921 to 1951 saw an increase of 43.7 per cent or an addition of 110 million people. It was from 1951- 1981 that India experienced an explosive population growth of 189.2 per cent or an addition of 322.2 million persons. The last three decades from 1981 to 2011 witnessed a high growth of population with some sign of slowing down. During this period the population increased by 526.7 millions.

Table: 1
Population of India: 1901-2011

Year	Population (million)	Decadal Growth rate %	Average Annual Exponential Growth Rate %	Density Sq. km.	Sex Ratio
1901	238.4	-	-	77	972
1911	252.1	5.75	0.56	82	964
1921	251.3	-0.31	-0.03	81	955
1931	279.0	11.00	1.04	90	950
1941	318.7	14.22	1.33	103	945
1951	361.1	13.31	1.25	117	946
1961	439.2	21.64	1.96	142	941
1971	548.2	24.80	2.20	177	930
1981	683.3	24.66	2.22	216	934
1991	846.3	23.85	2.14	267	927
2001	1027	21.34	1.93	324	933
2011	1210	17.6	1.51	382	940

Source: *Census of India various years*

Prior to 1921, population growth in India was sporadic and more or less stationary. Both birth rate and death rate were high during that period. The year of 1921, also known as the year of 'Great Divide', marks the difference in the growth pattern of population in India. The period between 1921-1951 saw rapid population growth, which was mainly because of decline in mortality and a large base population with little impact of family planning programmes, while the decade of 1951-1961 saw an explosive population growth, where 78 million persons were added to the Indian population. Between 1961-1971 about 109 million persons were added, while the next decade from 1971-1981 saw an addition of 135 million persons. Further, between 1981-1991 there was a net addition of 160 million persons and the last decade of the century from 1991-2001 saw an increase of 184 million persons. While in the latest decade from 2001-2011 it increased by 183 million persons. The significant point of the last decade was that India has entered a phase of Demographic transition characterized by declining fertility in some States and the increase in population has been primarily on account of a significant reduction in the death rate.

4.3 Basic measures and concepts in Demography

Demography is a branch of Social Science which studies population. Demography tries to cover different aspects in such a way that parts of this discipline belong to a number of subjects. There are economic demography, mathematical demography and statistical demography. Sociology and Anthropology also study demographic variables. It is an empirical science, it uses standard statistics in its empirical investigation. There are certain basic concepts of demography which are as follows:

4.3.1 Population or Universe

Any statistical investigation is concerned with one or more characteristics of a set of individuals or objects. This group of objects may be animate or inanimate, real or hypothetical, finite or infinite and is known as population or universe in a statistical sense. In short, population or universe is the totality of objects being investigated.

4.3.2 Sample

Most often the size of the population or universe is such that the entire things cannot be studied. Sometimes, the units of the population have the same characteristics. For example, a factory wants to test the glass plates manufactured by it. Since all glass plate have the same fragility, the factory can test only one glass plate. On the other extreme, when there is a huge variation in different units of the population, sample size must be large. In statistics, any representative part of a population or universe is called a sample.

4.3.3 Variable

In the study of demography, it is assumed that some underlying, unobservable process is occurring and this underlying process can be better understood by studying the characteristics of the population. Generally, the value representing a characteristic of a population may vary from individual to individual and over time and space. This type of characteristics is called a variable. For example, age of individuals in a population varies from individual to individual and is called a variable. There are two types of variables – discrete and continuous.

4.3.4 Scale of Measurement

All variables cannot be measured by the same scale. The nature of the scale to be used depends on the nature of the variable. Some variables can be measured by only values. Nominal scales others require the use of ordinal scales or class interval.

Nominal Scales **(NS)** – In the nominal scale the variables assume only a limited set of values without any hierarchical relationship with each other. For e.g. the variables like religion and sex of the individual comes under this category.

Ordinal Variables – These are positional values having cardinal effects. Variables which can be represented in an order of ascending or descending scale belong to the category of ordinal variables. For e.g. the socio-economic status which is normally represented by high, medium and low falls under this category.

Class Intervals – Variables whose values can be represented as falling within specified class intervals comprise the category of interval scales. For e.g. income and age are such types of variables. These values can be represented by cardinal numbers such as 1, 2, 3, or by fractions.

The main aim of demographic analysis is generally to identify and quantify as precisely as possible the various demographic phenomena through a variety of measures and indicators with a view to use them for making comparisons between populations and in a given population over time.

Measure: A Measure is a definitive quantitative value of the phenomenon being studied.
Indicator: An indicator is a proxy or an approximation to a measure. For example, while income is a measure of the economic status of an individual, the type of house he/she lives is an indicator of his/her income.

4.3.5 Ratios

A Ratio is the result of dividing the size of one of the two non-overlapping groups possessing some common characteristics by one or the other. An example is the number of males in a population divided by the number of females which is called sex ratio. A ratio is a helpful index in comparing the relative strength of each group in populations at different times and territories.

A ratio is a comparison between two variables or characteristics that belong to two different categories. That is, the objects being compared are disjointed. If in a class of 50 students, 20 have taken Biology and 30 have taken mathematics, the ratio between Biology - and mathematics taking students is 20: 30 or 2: 3. A very common example from demography is sex or gender ratio. This is the number of females per 1000 males. The gender ratio in Arunachal Pradesh is 938 and in India it is 940.

4.3.6 Proportions

A proportion is a relative number that expresses the size of one subgroup to the total of all subgroups which is equated to 1. When the sizes of all subgroups are expressed as percentages, the result is called a percentage distribution. In other words, a proportion is a special type of ratio in which the numerator is included in the denominator. If the characteristic under consideration is age, the distribution of persons at each age is called the 'age distribution' or the age composition of the population.

4.3.7 Rates

The most commonly used demographic measures are Rates. They express the number of events, say E, that occur in a population of size P in a given period of time, which is usually a year, as a fraction E/P. In a rate the numerator and denominator belong to the same categories: Their unit of measurement is the same that is dimensionally they are same. For example, in Crude Birth rate (CBR) which is defined as B/P x 1000, B is the number of live births in a year and P is the average population of that year.

Rate is a measure of the speed of occurrence of events in the population. Thus, the concept of rates is associated with dynamic phenomena such as growth, birth and death. A rate refers to the occurrence of events over a given interval of time. In demographic application, rates are normally considered as indicators of what is known in statistical parlance as 'occurrence/exposure', measures where the numerator is the number of events that have occurred in a population and the denominator is the duration of exposure of the population to such events. They contain a count of the number of events occurring within some defined time period in the numerator, and in the denominator, an estimate of the population during the middle of that time period.

4.4 Basic Demographic Equation:

The most basic equation that expresses the change in population over time in a single form is known as the Basic Demographic Equation or balancing equation. It is the decomposition of the population change into its component. It is expressed as follows:

$$P_2 = P_1 + B - D + I - E$$

Where, P_1 and P_2= Population at two different points of time; B = Number of Birth; D = Number of Death; I = Immigrants; E = Emigrants during the period.

$P_2 = P_1 + NI + NM$

Where, NI = Natural increase (B – D); NM = Net Migration (I – E)

4.5 Demographic Data Sources

The system of demographic data collection is the mechanism whereby information on some of the basic characteristics of the population such as its age, sex, marital structure and the various events that contribute to changes in this structure such as births, deaths, marriages, migration and other related topics is compiled and tabulated.

Demographic data can be categorized into two types: *Stock Data* and *Flow Data*.They are also called stock and flow. A stock is defined at a point in time, while a flow is defined over a period: at a point in time a flow is stock.

So, ***stock data*** denote the information pertaining to the situation of a population at a given point of time; these may be sex-distribution, marital structure, occupational structure, etc. It is a snap shot of the population at that point of time.
A ***flow data*** set pertains to events that occur over time. Example- deaths, births and migration. Deaths and out-migration reduce the size of population over time, while births and in-migration tend to expand the size of a population.

The most important sources of demographic data are Censuses, Vital Statistics and Sample Survey.

The most important and widely used demographic stock data at the national and sub-national level are from the population census.

The vital registration system or the system of compulsory registration of births, deaths and marriages is the major source of flow data.

An important source of demographic data that provide information on both the stock and the flow variables is the *sample surveys*. The analysts conduct a sample survey when they require detailed information on specific topics and the information available from the censuses and vital registration is not adequate in coverage and quality.

The fourth source of demographic information is the various administrative records and the service statistics, where data are compiled routinely -example, airport authorities on immigration and emigration.

4.6 Censuses: Definition given by the United Nations handbook of the Census (1958)

The Census is the total process of collecting, compiling and publishing of demographic, economic and social data pertaining to a specified time or times of all persons in a country or delimited territory. The Census refers to the population at a particular point of time.

In the Indian Census of 2011, this point of is the sunrise of 1st March 2011. This is called the Census reference date and time. The tools used are the Questionnaires, enumerator and respondents.

Primary unit census enumeration includes two levels of data: individual and family. At the individual level information relating to name, age, sex, relationship with the head of the family, marital status, occupation and migration and at the family level housing conditions, amenities are collected. General questions, employment status – full time or part time, nature of work etc. are also collected.

4.7 Vital Statistics

Vital registration is a system for the registration of the demographic events occurring in a population – births, deaths and marriages, and is the basic source of information on population dynamics.

4.8 Basic Measures of Fertility

The three major demographic events which effect the population size of an area are births, deaths and migration.

Fertility refers to actual reproductive performance of a woman or the number of children a woman has or the average number of children for a group of women. Sometimes we also use the term Natality. Fertility is possible only when a woman attains menarche (adulthood) and ends with her menopause.

The term Fecundity is used to connote the physiological capacity to bear children and is the opposite of the term sterility. No direct measurement of fecundity is possible, whereas fertility is the actual performance in reproduction - measurable empirically.

4.9 Types of Analysis: Period and Cohort measures

The analysis of fertility is basically carried out in two ways - one is in a period perspective and the other in a cohort perspective.
In the period perspective, the events that occur in a given period of time, a year or a month are studied in relation to the durations of exposure of the population during that period. The period measures can look at fertility rates in a cross-sectional way, to get a comparative picture during the reference year or years.

In cohort perspective the events and duration of exposure are studied for well-defined cohorts as they move over time. The term ‘cohort’ indicates a group of people who have a similar experience at the same time.

Two types of cohorts are generally used in demography – birth cohorts i.e. those born in the same year or period and marriage cohort, those who are married in the same year or period. The fertility measures considered in a longitudinal way are called cohort measures.

4.10 Child-Women Ratio (CWR)

This is one of the simplest measures generally used in the fertility analysis and is defined as –

$$CWR = \frac{{}_5P_0}{{}_{35}W_{15}} \quad X \quad 1000$$

${}_5P_0$ = Number of children under 5 years of age in a particular time.

${}_{35}W_{15}$ = Number of women in the age group 15-49 (Reproductive span) in a particular time.

The subscript 15 on the right of W indicates the beginning of the age interval and the subscript 35 on the left of W indicates the duration of the interval beginning at age 15.The denominator may sometimes be 15-44. Basically, it is a crude measure and if fertility is high the ratio will be high and if fertility is low the ratio will be low.

4.11 Crude Birth Rate (CBR)

This is the most widely used measure of period fertility. It is defined as –

$$\text{CBR} = \frac{\text{Number of births during a year}}{\text{Population at mid} - \text{year}} \text{ X } 1000$$

This measure is the simplest and most available of all measures of fertility. This is the common measure of fertility, and it is simple in concept and measurement. The rate is called crude because it includes all ages and both sexes in the denominator.

4.12 General Fertility Rate (GFR)

The CBR uses the entire population in the denominator. A more meaningful measure is to use only women of the reproductive age group in the denominator.

$$\text{GFR} = \frac{\text{Number of births during a year}}{\text{Mid} - \text{year female population aged } 15 - 49} \text{ X } 1000$$

4.13 Age-specific Fertility Rates (ASFR)

The denominator of general fertility rate (GFR) uses all women in the reproductive ages and in the age- specific fertility rate (ASFR) both the numerator and the denominator pertain to births and number of women in a specific age or age group.

$$\text{ASFR at age X} \quad = \frac{\text{Births to women aged X in a year}}{\text{Mid} - \text{year female population aged X}} \text{ X } 1000$$

OR

$$\text{ASFR (in age group X, X + n)} = \frac{\text{Births to women aged X to (X + n) in a year}}{\text{Mid} - \text{year female population aged X to(X + n) in a year}} \text{ X } 1000$$

Generally, five-year age groups of women are used in calculating the rate. For e.g. 15-19, 20-24, 25-29, 30-34…….45-49.

4.14 Total Fertility Rate (TFR)

The Sum of the ASFRs over different ages 15 to 49 or 15-44 is known as total fertility rate. Thus,

TFR = Sum of ASFRs

It is the most widely used measure of fertility by demographers. The TFR is generally expressed as number per women. This measure can be thought of as the number of children a woman would have if she survived to age 50 and throughout her reproductive life span if she is subjected to a fertility schedule. The importance of TFR is that it is a single figure and is independent of age structure.

4.15 Gross Reproductive Rate (GRR)

Gross reproductive rate (GRR) is another summary measure of period fertility rate. This rate is essentially a TFR, with the modification that it is computed only for female births. Thus, GRR is the average number of daughters that would be born to a woman during her lifetime if she passed through the childbearing ages experiencing the average age-specific fertility pattern of a given period.

$$GRR = TFR \times (1/1+S)$$

Where, S = Sex ratio (We assume sex ratio at birth as 1.05)

4.16 Net Reproductive Rate (NRR)

The Net Reproductive Rate (NRR) is the rate at which the female population replaces itself. It is an index for the self-replacement potentiality of a population with given age-specific rates of fertility and mortality. It means that if we want to calculate the rate of population growth, we must ask, "what is the total number of daughters that would have been born to 1000 new born girl babies by the time the latter have all completed their life span". For example, if the total number of girls being born to 1000 women in child-bearing age (15-45 or 50 years) is 1000, then the NRR will be 1. This shows that the present generation of females would, on death have been fully replaced by the new born babies (girls) and the population will be constant. If only 800 (Girts) babies are born to such 100 women of child -bearing age, the NRR will be 0.8 and if in the long run, it continues, the population will definitely decrease. Thus, the rate at which the female population is replacing itself is the net reproduction rate. It indicates how rapidly the population would ultimately grow, if the risks of death and the fertility of each group remained unchanged and there were no migrations.

$$\text{Female net reproduction rate} = \frac{\text{Number of female children expected to be born to 1000}}{1000}$$

OR

$$\mathbf{N}RR = \frac{\sum B_f \times S}{1000}$$

$\sum B_f$ =Total number of female birth expected to 1000 newly born female children

S = Survival rate

However, even the net reproduction rate as a measure of replacement of population cannot be much relied upon because of the following two reasons.

1. The population of the country may become depleted more by migration than by falling birth rate or the country may receive fresh stock of immigrants who might be more virile.
2. It assumes constant rates of fertility and mortality over a generation. In actual life both these rates go on changing.

4.17 Economic Theories of fertility:

Becker's Theory

There are several economic theories to explain how decisions on the number of children are made by couples. Economic theories of fertility are based on the assumption that decisions regarding family size are influenced mainly by economic considerations, and therefore these theories are built within the micro-economic framework.

In 1960 Becker in his famous article on 'An Economic Analysis of Fertility', put forward his economic theory of fertility. Becker applied the micro consumption theory of fertility. His theory was based on the argument that fertility behavior is the result of household choice.

In the economic theory of household behaviour, the choice of durable goods by a consumer with a given taste is considered to be made after a careful evaluation of the utility derived from the concerned goods and the costs to be incurred as well as his income.

Becker considered children to be the same as thecommodities consumed in the household and argued that the household choice of fertility is made in the same manner as in the case of the purchase of durable goods. A couple's decision to have an additional child according to Becker's point of view depends on the balance of its preference, the constraints of its income and the costs of the child.

Becker's argument rested on two assumptions: (1) the representative households behaves rationally on the basis of unchanging tastes, and (2) the prices of commodities desired by the representative household are unaffected by that household's consumption decisions.
According to Becker if knowledge of birth control methodsis widespread, and the price of children, the cost of child bearing and rearing remain unchanged, fertility would be directly related to the income of the parents. Becker attributed the inverse relationship between income and fertility to the rise in price of children because of rising time cost of child rearing and differential knowledge of birth control in various income groups. According to him, once such knowledge is evenly spread, a positive association would emerge between income and fertility.

Becker's theory was not free of criticism. Richard Easterlin, challenged Becker's theory and raised thepoint that tastes cannot be taken as immutable facts and insisted that tastes change systematically according to one's upbringing. He introduced the sociological concept of socialization into economic theory. According to Judith Blake, Becker ignored the sociological determinants of reproductive behaviour.

Richard Easterlin's Theory

Richard Easterlin challenged Becker's theory in 1966 and since then two rival schools of the economics of fertility have emerged. One headed by Gary Becker and the other by Richard Easterlin, who raised the point that tastes cannot be taken as immutable facts and insisted that tastes change systematically according to one's upbringing. He thus introduced the concept of socialization into economic theory. He however accepted Becker's second assumption that the prices of commodities desired by a representative household are unaffected by the household's consumption decisions.

According to Easterlin, a comprehensive economic framework incorporating the main concepts of demography, sociology and other sciences would be useful to analyses human fertility behavior in a systematic manner. Such a framework, it was thought should be relevant to present and past fertility behaviour in a large number of societies and it should also deal with the trends, fluctuations and differentials observed in fertility during the course of human history.

Easterlin proposed a framework in which an attempt has been made to combine sociology and Economics of human fertility. As parents are more concerned about the number of grown-up living children rather than the number of births, the principal dependent variables in Easterlin's theory is the total number of surviving children. It is also assumed that both spouses would live throughout the reproductive span of wife.

The determinants of fertility are as follows:

1. **The Demand for Children (Cd)**: The demand for children (Cd) is the number of surviving children the parents would want if fertility regulation were costless. The demand for children is ascertained by obtaining the information on the number of children desired by the couple. In keeping with the economic theory of the household choice, the immediate determinants of demand for children are income, price and taste.

   Thus, the factor demand for children deals with the individual choice about the number of surviving children and the social, economic and environmental factors or conditions that influence the choice.

2. **Potential output of children (Cn): Supply of children:** The production of children or child bearing in any society is a biological function shaped by various cultural practices. The number of surviving children a household would have if fertility is not deliberately controlled, is the potential output of children (Cn). The potential output of children is a product of a couple's natural fertility (N) and the survival rate i.e. probability of a new-born baby surviving upto adulthood. Natural fertility is determined by biological and cultural factors. Increase in couple's natural fertility and improvement in the chances of child survival would increase the potential supply of children.

Motivation for fertility regulation = Cn – Cd

The demand for surviving children and the supply of children together determine the motivation of fertility regulation.

If the potential output is smaller than demand i.e. Cn is less than Cd (Cn < Cd), there is no desire to limit fertility. Such a situation of 'excess demand' would call for way and means to increase fertility.

If the potential output of surviving children is larger than the demand for surviving children i.e. Cn is greater than cd 9 Cn > cd, this could be considered as a situation of 'excess supply'.

In an 'excess supply' situation parents would be faced with the prospect of having unwanted children. If this excess is larger, the potential burden of unwanted children would be greater and hence as a consequence the households motivation to limit its family size is also greater.

3. **The costs of fertility regulation:** The adoption of means of regulating fertility depends upon cost of fertility, regulation, which includes subjective costs and objective costs such as money required to learn about and use a specific method. Motivation, attitude and access are the three important factors influencing adoption of fertility control.

It can be seen that in pre-modern society, demand (Cd) is greater than supply (Cn) and actual family size corresponds to supply. As Socio economic development advances an excess supply condition emerges which generates motivation for fertility control. In the beginning this motivation is low and does not offset regulation costs sufficiently to result in deliberate fertility control – hence actual family size continues to corresponds to supply. As socio-economic development progresses with motivation growing and fertility regulation costs going down, at some point deliberate restriction sets in. Eventually family size falls to a level where Cn is equal to Cd.

4.18 Key words:

Demography, Universe, Variable, Census, Vital Statistics, Crude Birth Rate, Total Fertility Rate, General Fertility Rate, Child Women Ratio, Gross and Net Reproduction Rate

Unit V
MORTALITY

Structure

5.0. Introduction

Mortality analysis is one of the most important branches of demographic studies and is the one with which demographers have been engaged from the very beginning of any systematic study of human populations. This branch deals with the demographic event of death. Measurement of mortality received much attention from actuaries during the 18th and 19th centuries. Thus, the techniques for analyzingmortality have a longer history and are more developed than those for analyzing fertility. Since death is a biological phenomenon that occurs just once to each individual, the analysis is simpler than, say, the study of fertility wherein the event of birth can occur with varying frequency among women. In this section we discuss the basic measures generally used in demographic analysis.

Mortality analysis is concerned with the study of the ‘risk of dying’ as it varies from one population to another and within a population from one subgroup to another. The study of mortality is of vital interest to researchers and planners involved in the public health programmes, to governmental and other agencies who are concerned with taking policy

decision in relation to the levels and variations of mortality, to life insurance companies which study mortality to fix the premium and to medical professionals who need to understand the prevailing patterns of various causes of death with their varying importance. It is an instrument in the hands of demographers to measure the growth potential of a population to look into the probable changes in population composition, to assist in the study of demographic variables and to make population projections.

5.1. Learning Objectives

After going through the chapter, you should be in a position to answer the following questions:

What are the various measures of Mortality?

What is age specific mortality Rate? Show the relationship between age and mortality rate.

What is a Life table? Discuss the uses of Life table?

Derive the probability of dying from the age specific death rate in case of both abridged and complete Life tables?

Discuss the trends of mortality in developed and developing countries.

Distinguish between exogenous and endogenous factors determining the mortality in childhood.

5.2. Measures of Mortality

5.2.1 Crude Death Rate (CDR)

Crude Death rate is a simple and direct measure of occurrences of deaths in a population. This rate relates to the number of deaths during a year to the mid-year population of that year. The rate is expressed normally per thousand of population. It is a measure of totality, describing the total frequency of deaths occurring in a population during a specified period, which is normally taken to be a year. So,

$$\text{Crude Death Rate (CDR)} = \frac{\text{Deaths in a year}}{\text{population at mid year}} X\ 1000$$

The denominator in this case uses the total population with varying risks to death and hence CDR does not measure the risk of dying for a person in the population in the probabilistic sense. This measure is generally a poor indicator of mortality as it does not take age structure of the population into account. The number of deaths is a function of the size of the population, its age-sex structure and its overall health condition. The risk of dying, generally high in the infancy and childhood, declines drastically thereafter up to age 20 and then rises slowly but steadily increasing sharply at ages above 50. This type of curve, known as the reverse J-shaped curve is characteristic of age patterns of mortality in all populations. Many developing countries with high fertility show a lower CDR than developed countries because the former have a much larger proportion of their population at younger ages, while the latter have an old population. A crucial factor in the study of mortality is to take account of its variations by age.

5.2.2 Age-Specific Death Rates (ASDRs)

As the relative frequency of deaths varies with age, a better comparison can be made in terms of the death rates calculated separately for each age. It can separate the component of mortality from the inherent effect of age composition on the number of deaths and its ratio to the population.

The CDR is the weighted average of the age-specific rates, the weights being the population size at each age. The death rates may vary not only by age but differently for the two sexes. The age-specific rates (ASDR) for males and females separately, are the commonly used specific rates. The ASDR ($_nM_x$) for the age group x to x + n is defined as:

$$_nM_x = \frac{_nD_x}{_nP_x} \times 1000$$

Where ,

$_nD_x$= number of deaths between x and x + n in the year

$_nP_x$= mid-year population aged between x and x + n

The curve of ASDRs is usually U-shaped in less developed countries with poor health status, the two sides of the ‘U’ representing the high mortality at infancy and old-age. The observation of the countries where mortality declined in the past is that the risk of mortality

decreases first at the infancy and childhood, where it was previously extremely high and produces a nearly J-shaped curve. The base of 'U' also widens as the lowered mortality becomes a trait of increased life expectancy. Further in the developed countries with low mortality, ASDRs for females are generally found to be lower at all ages than for males. In underdeveloped countries, however there arise various typical differences in the ASDRs for the two sexes. One such typical pattern is of higher female mortality than that of males at infant and reproductive ages and the opposite trend is to be seen for other ages. The case of India confirms such a pattern of sex-differentials in mortality.

5.2.3 Infant Mortality Rate

Infant and child mortality rates reflect a country's level of socio-economic development and quality of life and are used for monitoring and evaluating population and health programmes and policies.

The segment of the population at greater risk of dying are the new borns, the early neonatal stage carrying the highest probability of dying. Once infancy is passed, the risk of dying declines first slowly and then rapidly after a year. Infant mortality Rate (IMR) is defined as the number of deaths under age one during a specified period divided by the number of live births in the same period and is usually expressed per thousand live births. Thus, the infant mortality rate is a measure of health status in the initial stage of life.

$$\text{IMR} = \frac{\text{Number of infant deaths under 1 age during a year}}{\text{Number of live births in the same year}} X\ 1000$$

The measure is not a proper rate but a ratio, as the denominator is not the population at risk of the events in the numerator. Some of the deaths under age 1 in the given year may be among the births which occurred during the previous year and some of the newborns during the year may die in the next year before reaching the first birthday. Also, the risk of dying during the first years of life is not uniform in the interval. The risk is maximum soon after birth and decreases slowly. During the early weeks, the causes of infant deaths tend to be different from those which occur later.

5.2.4 Early Neonatal Mortality

Infant Mortality Rate is often broken down into three parts, by dividing the first years of life into periods based on the intensity of risk of mortality. The first one week of life is found to have high risk and the number of infant deaths within one week of birth is termed as **early neonatal mortality**.

5.2.5 Neonatal Mortality

Further, the first four weeks or one month is also found to have a very high risk and the number of infant deaths during this period is termed as **Neonatal Mortality**. The Neonatal Mortality Rate (NMR) is defined as,

$$\text{Neonatal Mortality Rate (NMR)} = \frac{\text{Deaths of babies less than 4 weeks old (neonatal infants)}}{\text{number of live births during the same year}} \text{X1000}$$

5.2.6 Post Neonatal Mortality

The deaths of infants after four weeks but before the first birthday are termed as **Post-Neonatal Mortality (PNMR).** The rate (PNMR) is defined as:

$$\text{PNMR} = \frac{\text{deaths of babies ages } 4-52 \text{ weeks during a year}}{\text{number of live births during the same year}} \text{X1000}$$

5.2.7 Child mortality rate ($_4q_1$)is the probability of dying between the first and fifth birthday or deaths of children aged 1 to 4

Under-five mortality rate is the total number of deaths aged less than five divided by the total child population that is those aged less than five. This rate is usually experienced per thousand.

For both social and biological reasons infant and child mortality rates often exhibit a U-shaped pattern with respect to the mother's age at childbirth, with children of the younger and older mothers experiencing higher mortality rates than children whose mothers

are in their prime reproductive ages. Children born to young mothers are more likely to be of low birth weight, which is probably an important factor contributing to their higher neonatal mortality rate. Similarly, children born to mothers above age 30 are at a relatively high risk of experiencing congenital problems. The expected U-shaped pattern of mortality by mother's age is observed for all indicators of infant and child mortality in India. Birth order also tends to have a U-shaped relationship to deaths of infants, with first births and high order births having elevated mortality rates. Antenatal, delivery and post-natal care is usually associated with lower child mortality.

5.2.8 Maternal mortality

Estimates say that 100,000 women in India die every year from causes related to pregnancy and child birth. These findings reinforce the urgency of ensuring that all pregnant women should receive adequate antenatal care during pregnancy and that deliveries should take place under hygienic conditions with assistance of trained medical practitioners.

5.2.9 Maternal Mortality ratio (MMR) is a widely used type of cause-specific mortality rate representing approximately the risk of dying as a result of complications of pregnancyand puerperium. This ratio is generally defined as the number of deaths due to puerperal causes per 100,000 live births

$$MMR = \frac{D_P}{B} X \ 100{,}000$$

D_P = Number of deaths during a year due to puerperal causes (deaths that occur to mothers because of complicacy of pregnancy or delivery related problems.

B = Total number of live births in the same year.

5.2.10 Maternal Mortality Rates

Maternal mortality rate represents the risk of dying as a result of complications of pregnancy, and puerperium. This ratio is generally defined as the number of deaths due to puerperal causes per 100,000 married women aged 15-49. If the denominator uses the number of married women, then the measure is called Maternal Mortality Rate.

$$\text{Maternal Mortality Rate} = \frac{D_P}{\text{Number of married women aged 15-49}} \times 100{,}000$$

Thus, maternal mortality rate is defined per 100,000 married women and Maternal mortality ratio is defined per 100,000 live births.

5.3. Life Table

The statistical model which combines the mortality rates of a population at different ages into a single set-up is called a life table. Life table are principally used to estimate the level of mortality of a population at different ages. In actuarial science and demography, a life table which is also called a mortality table or actuarial table is a table which shows for each age, the probability that a person of that age will die before his or her next birthday. In other words, it represents the survivorship of people from a certain population. It was first developed by John Graunt in 1663. However, Halley in 1693 was the first to develop a life table which contained most of the columns of present day life table.

Uses

1. Life tables are principally used to estimate the level of mortality of a population at different ages.
2. The Life table is a powerful tool for the analysis of mortality and it provides the most complete way of comparing the mortality of different populations.

3. It is generally used by public health workers, demographers, actuaries and many others in studies of longevity and population growth, as well as in making projections of population size and also in studies of widowhood, orphanhood, length of married life, length of working life etc.

4. Life insurance companies use the life table age specific death rates (ASDR) to estimate the ASDR of a population and this information is used to fix the premium of an insured life.

Types of Life Table

Life tables are generally constructed for two types of age categories. If life table information is given for each year of age it is referred to as a complete life table.

If one uses age groups instead of a single year of age, it is called an Abridged Life table (ALT). ATLS are the ones commonly used by demographers.

If one constructs a life table based on the occurrence of deaths within a cohort of individuals born in the same year or group of years, it is called a cohort life table. Thus,a cohort life table is often referred to as a generation life table and it represents the overall mortality rates of a certain population's entire life time.

However, a period life table assumes a hypothetical cohort and is based on the experience of age-specific rates of a particular period and is normally used in mortality analysis. Period life table represents mortality rates during a specific time period of a certain population. Basically, it is used when the time period is short.

Assumptions of a Life Table

1. The cohort under study is closed to migration. Its size decreases only through attrition of death of its members.

2. Each member of the cohort is exposed to the risk of death at each age according to the schedule which is fixed in advance and is unchanged.

3. The size of the cohort is always a fixed number of births of the same sex say, 10000 or 100000 which is called the radix of the life table.

4. The number of deaths during the year is assumed to be evenly spread over the age interval, (except the first few years) especially when it is one year.

Columns of a Life Table

A life table, as the name suggest, is usually presented in a tabular form. It consists of seven basic columns. The various rows represent the set of life table functions by age.

Column 1: This column represents age (x): for a complete life table, x takes on **(x)** values 0, 1, 2……, when age interval is more than a year, it is called an abridged life table. When age interval is 5, x takes on values 0, 5, 10,…….. In general when age interval is c, x takes on values 0, c, 2c, 3c, …..w , w being the last considered age.

Column 2: In case of a complete life table the probability of dying between an exact age X $_nq_x$ and exact age x+1 is q_x . For an abridged life table with age interval n, the probability of dying between exact age x and exact age x+n is $_n\mathbf{q_x}$

Column 3: Radix of the life table or the base of the life table i.e. survivors of initial cohort of l_x age x(l_x). This column represents survivorship

Column 4: Number of deaths between exact age x and x+n is $_nd_x$. In a complete life table, where n = 1, the number of deaths between exact age x and exact age x+1 is dx.
When age Interval is n, it is $_nd_x$ as mentioned before.

Column 5: Number of survivors between age x and x+n, $_nL_x$. This column shows the age $_n\mathbf{L_x}$ distribution of the life table population i.e. the person years lived between exact age x and exact age x + n

Column 6: It stands for total or aggregate population of the life table: the total years, T_x lived by survivors, at age x. When x = 0, $T_X = T_0$
$T_{0:}$ Aggregate population; T_{10}: Total population aged 10 and above;
$T_{20:}$ Total Population aged 20 and above, and so on

Column 7: Life expectancy at age X is (e_x^0). The average number person years a survivor of **e_x^0** Age x expects to live is $e_x^0 = T_x / l_x$

The expectation of life at age x (e_x) is the end product of life table.

Relationship between Life table functions

In a life table there are two types of functions – one type relates to a point in time and the other type refers to a period of time. In economics, variables defined at a point in time are called stock variables, for example: capital, population, etc, while the variables which are defined for a period of time are called flow variables; common examples being income, consumption, etc. At a point in time a flow variable vanishes to zero. Similarly, in life table, x the exact age refers to a point in time while ${}_nq_x$ refers to a period of time. At a particular point in time the probability of dying is zero. Of course, when the time period is very small, in the limiting case of the vanishing time, the number of deaths represents what is called 'force of mortality'. l_x is stock variable defined at a point in time.

Lx or ${}_nL_x$ refers to a period of time. L_x is the size of the lifetable population in the age interval x and x + 1. If age interval is n, then ${}_nL_x$ refers to the number of survivors (Life table population) aged x and x +n . More technically or in the demographic language, L_x is called person years lived between exact age x and x +1. When age interval exceeds 1, we have ${}_nL_x$, n being the interval of x, and ${}_nL_x$ is the person years lived between exact age x and exact age x + n. L_x represents the age distribution of the life table population. The sixth column, T_x represents the total person years lived after age x. T_0 is the total population of the life table. Lastly, $e^0_x = T_x / l_x$ and e^0_x is the life expectancy at age x.

Formulae's used

From the given age-specific death rate, ${}_nM_x$; the probability of dying ${}_nq_x$ can be derived as below: by definition ${}_nM_x = {}_nd_x/{}_nL_x$ Where, ${}_nd_x$ is the number of deaths in the age interval x and x + n in the population being studied and ${}_nL_x$ is the size of the population in the same age interval.

Therefore,

$$ {}_nM_x = \frac{{}_nd_{xn}d_x/l_x}{{}^n/_2\,(l_x + l_{x+n})} = \frac{{}_nq_x}{{}^n/_2(l_x + l_{x+n})/l_x} = \frac{2({}_nq_x)}{{}^n/_2\,(1 + l_{x+n}/l_x)} $$

$$ {}_nM_x = \frac{2\,({}_nq_x)}{n(2 - {}_nq_x)} $$

$$ {}_nM_x = \frac{{}_nd_{xn}}{{}_nL_x} = \frac{d_x}{{}^n/_2\,(l_x + l_{x+n})} $$

Dividing both the numerator and denominator by l_x, we have

$$ {}_nM_x = \frac{{}_nd_x/l_x}{{}^n/_2\,(l_x + l_{x+n})/l_x} $$

Again, multiplying both the numerator and the denominator by 2,

$$ {}_nM_x = \frac{2.\,{}_nq_x}{2.\,{}^n/_2\,(l_x/l_x + l_{x+n}/l_x)} $$

We know that ${}_nd_x/l_x$ is the probability of dying between exact age x and exact age x+1, that is ${}_nd_x/l_x = {}_nq_x$.

Again l_{x+n} is the number of survivors at exact age x+n and l_x is the number of survivors at exact age x, therefore $l_{x+n}/l_x$is the probability of surviving age, x+n or $l_{x+n}/l_x = {}_nP_x$ which is same as $1 - {}_nq_x$

Therefore,

$$ {}_nM_x = \frac{2({}_nq_x)}{n\,(1+1-{}_nq_x)} $$

$$ {}_nM_x = \frac{2({}_nq_x)}{n\,(2 - {}_nq_x)} $$

Or, $2({}_nq_x) / n\,(2 - {}_nq_x) = {}_nM_x$

Or, $2({}_nq_x) = 2n\ ({}_nM_x) - n\ ({}_nM_x)\ ({}_nq_x)$

Or, $2\ ({}_nq_x) + n\ ({}_nM_x)\ ({}_nq_x) = 2n\ ({}_nM_x)$

Or, ${}_nq_x[\ 2 + n\ ({}_nM_x)] = 2n\ ({}_nM_x)$

Therefore, $${}_nq_x = \frac{2n({}_nM_x)}{2 + n\ ({}_nM_x)}$$

$${}_nq_x = \frac{1.\ \ 2n\ ({}_nM_x)}{2 + n\ ({}_nM_x)}$$

Where ${}_nM_x$ = Age specific Death Rate (ASDR) per person.

Age specific death rate is transformed into probability of dying by the formula

$${}_nq_x = \frac{2n\ ({}_nM_x)}{2 + n\ ({}_nM_x)}$$

In the problem given suppose n = 10

Therefore, $${}_{10}q_x = \frac{2 \text{ x } 10\ (10\ M_x)}{2 + 10\ (10\ M_x)}$$

Using this formula, age specific death rate is transformed into the probability of dying.

2. L_x is assumed to be given and its value is equal to 100000.
3. ${}_nd_x = {}_nq_x \text{ x } l_x$
4. ${}_nL_x = n/2\ (l_x + l_x + n)$
5. T_x= Cumulative of ${}_n L_x$
6. $e_x = T_x / l_x$

5.4. Trends of Mortality in Developed and Developing Countries

During the twentieth century, mortality had the most rapid decline in the history of humanity. Although the sustained reduction of mortality started in the eighteenth century, it gained momentum in the early part of the twentieth century as better hygiene, improved nutrition and medical practices based on scientific evidence became the rule in the more advanced countries. Despite the setbacks brought about by the two world wars, by 1950-1955 the widespread use of antibiotics and the growing use of vaccines had contributed to reduce mortality markedly in the more developed regions and the average life expectancy at birth for their populations had reached 66.2 years. It increased to 74.9 years in 1995-2000 and in 2017-18 it further increased to 78.9 years. The mid-century also marked an important turning point in the less developed regions. With the expanded use of antibiotics, vaccines and insecticides, mortality in the developing world began to decline rapidly, so that life expectancy increased by 53.4 per cent between 1950-1955 and 1995-2000 rising from 41 years to 62.9 years and further to 69.8 years in 2017-18. As a result, the world's life expectancy at birth increased from 46.5 years in 1950-1955 to 65 years in 1995-2000, a gain of 18.5 years and further to 71.4 years in 2017-18. Furthermore, the mortality differentials between the less developed and the more developed regions narrowed, so that by 1995-2000 the difference in life expectancy between the two groups amounted to 12 years instead of the 25.2 years difference that existed in 1950-1955 (Table:1)

As regard to life expectancy at birth by major area, it is observed that Africa (61.5 years) has the lowest, followed by Asia (72.4 years), while North America (79.5 years) has the highest, closely followed by Oceania (78.4 years) and Europe (77.7 years) during 2017-18 (Table: 2).

There remains, however, a group of countries where the reduction of mortality has lagged behind. In the least developed countries life expectancy rose from 35.5 years in 1950-1955 to 50.3 years in 1995-2000, a 41.6 per cent gain, but the difference between their life expectancy and that of the less developed regions as a whole increased from 5.5 years in 1950-1955 to 12.6 years in 1995-2000. A major reason for such increase is that the 48 countries classified as least developed include 26 that are highly affected by HIV/AIDS epidemic. Furthermore, the less developed regions include several very populous countries

that have made strides in reducing mortality and where levels of life expectancy are today similar to those of more developed regions.

China, with a 1.3 billion population, is among those countries. Clearly, the countries that constitute the less developed regions are heterogeneous both in terms of the levels of life expectancy achieved and with respect to the pace at which those levels have been reached. In the long run, however, mortality differentials between the major development groups are expected to narrow further. By 2045-2050, life expectancy at the world level is expected to reach 76 years, being the result of 82.1 years of life expectancy in the more developed regions and 75 years in the less developed regions as a whole, among which the least developed countries are expected to reach a life expectancy of 69.7 years. Consequently, the difference in life expectancy between the less developed regions as a whole and the least developed countries is expected to decrease significantly in the future, reaching 5.3 years in 2045-2050, a figure similar to that estimated for 1950-1955.

Table: 1
Life Expectancy at Birth for the World and Development Groups:
For Selected Period: 1950-2050

Year	World	More Developed Regions	Less Developed Regions	Least Developed Regions
(1)	(2)	(3)	(4)	(5)
1950-1955	46.5	66.2	41.0	35.5
1995-2000	65	74.9	62.9	50.3
2017-2018	71.4	78.9	69.8	63.7
2045-2050	76.0	82.1	75.0	69.7

Source: World Population Prospects, 2017-18

Table: 2
Life Expectancy at Birth by Major Area for Selected Periods: 1950-2050

Year	Africa	Asia	Latin America and the Caribbean	Oceania	Europe	North America
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1950-1955	37.8	41.3	51.4	60.9	65.7	68.9
1995-2000	51.4	65.8	69.3	73.5	73.2	76.7
2017-2018	61.5	72.4	75.2	78.4	77.7	79.5
2045-2050	69.5	77.1	77.8	80.6	80.8	82.7

Source: World Population Prospects, 2017-18

Trends of Mortality in the World

Worldwide, the number of years that a new born is expected to live, if current mortality patterns remain constant in the future, exceeded 71 years in 2015 and the life expectancy at birth is still growing. The history of increasing life expectancy at birth, however, is not long. In most countries, it started only after the Second World War. The fast increase of life expectancy at birth reflects the success of human development. Yet remarkable differences exist in mortality levels, age patterns and time trends between countries and regions. The socioeconomic implications of the diverse mortality levels and age patterns, their dramatic changes and their potential future trends are critical for understanding the implementations of the 2030 Agenda for Sustainable Development. "Global Health and Well-Being", one of the goals (No. 3) of sustainable development comprises targets that contribute directly to rising life expectancy.

Life expectancy at birth reached unprecedented high levels, but significant differences persist across regions

In 2015, the average life expectancy at birth for Africa, where 16 per cent of the world's population lived, was 61 years; and the average life expectancies for the other five regions, where 84 per cent of world's population lived, varied between 70 and 80 years. Across regions, the highest life expectancy at birth was 80 years in Northern America, where 5 per cent of the world's population lived, followed by Europe and Oceania with 78 years and 11 per cent of the world's population, Latin America and the Caribbean with 75 years and 8 per cent of the world's population, and Asia with 72 years and 60 per cent of the world's population.

Average life expectancy at birth for the world was 64.2 years in 1990

In 1990, the average life expectancy at birth for the world was about 64 years. Life expectancy at birth was below 60 years in 55 countries most of which were in Africa, between 60 and 69 years in 64 countries, and 70 years or higher in 82 countries. No country had yet reached a life expectancy at birth above 80 years in 1990.

Average life expectancy at birth for the world reached 71.4 years in 2015

In 2015, the average life expectancy at birth for the world had risen to more than 71 years. Life expectancy at birth was below 60 years in only 21 countries, between 60 and 69 years in 49 countries, between 70 and 79 years in 97 countries and 80 years or higher in 34 countries. Most countries with low life expectancy are in sub-Saharan Africa.

Increases in life expectancy at birth between 1990 and 2015 were remarkable, but uneven between regions

In Africa, the life expectancy at birth increased by 9.7 years between 1990 and 2015 During the same period, Africa's population grew from 635 million to 1.2 billion. Africa's increase of life expectancy was the largest among the six regions. Africa was followed by Asia, where the life expectancy at birth increased by 8.0 years between 1990 and 2015, while the population grew from 3.2 billion to 4.4 billion. The two regions were more influential than the others in driving the overall improvement in life expectancy for the world because their life expectancies increased rapidly and they contained a large share of the world's population.

Compared to Africa and Asia, life expectancy at birth was higher and population growth was slower in Europe, Latin America and the Caribbean, Northern America, and Oceania. The life expectancy at birth increased by 4.9 years between 1990 and 2015 in Europe and 4.1 years in Northern America. The increases in Latin America and the Caribbean, at 7.1 years, and Oceania, at 6.1 years, were considerably faster than in Europe and Northern America. Therefore, the disparities in life expectancy at birth among the four regions declined between 1990 and 2015

Great success in reducing child mortality was achieved between 1990 and 2015, but more progress is needed to reach the SDG target

Child mortality, or under-five mortality, is the probability of dying between birth and age 5 years expressed per 1,000 live births. The reduction of child mortality by two thirds between 1990 and 2015 was the central target of Millennium Development Goal (MDG) 4 of the United Nations Millennium Declaration and the further reduction to below 25 deaths of children under age 5 per 1,000 live births by 2030 is target 3.2 of the Sustainable Development Goals (SDGs).

Of the six regions, only Europe achieved the MDG target, with a two thirds reduction of the under-five mortality rate between 1990 and 2015. Europe was followed by Asia with a reduction of 60 per cent, and Latin America and the Caribbean with 59 per cent. In Northern

America, the under-five mortality rate declined by 42 per cent between 1990 and 2015 and in Oceania it fell by 35 per cent. In Africa, under-five mortality declined by 53 per cent between 1990 and 2015, while the number of children aged 0-4 years grew from 110 million to 187 million. By contrast, in all other regions, the number of children under age five was unchanged or declined.

Africa is unlikely to reach the SDG target for the reduction of child mortality by 2030

Based on the most reliable estimates, the 2017 Revision of World Population Prospects projects that, in 2030, under- five mortality in Africa would be 54 deaths under age 5 per 1,000 live births. While that would mark a substantial reduction from 2015, when there were an estimated 80 deaths under age 5 per 1,000 live births in Africa, it would remain far above the SDG target of 25 deaths under age 5 per 1,000 live births. By contrast, Asia is projected to achieve the SDG target for under-five mortality by 2030. Latin America and the Caribbean (LAC) and Oceania achieved under-five mortality below 25 deaths per 1,000 live births before 2015 and Europe and Northern America did so even before 2000.

Whether or not Africa will achieve SDG target 3.2 depends on the average annual rate of decline of the under-five mortality rate over the period from 2015 to 2030. The projected average annual rate of decline during 2015-2030 for Africa is slower than that estimated for 2000-2015. To reach the 25 per 1,000 under-five mortality target in 2030, Africa would need to achieve an average annual rate of decline of about 8 per cent during 2015-2030. Since 8 per cent is significantly faster than the average annual rates of decline estimated for 2000-2015 for each of the six regions, it is unlikely that Africa will achieve SDG target 3.2 without an unprecedented effort to accelerate the pace of reduction of child mortality in many countries.

Reductions of adult mortality between 1990 and 2015 were much slower than for child mortality

Adult mortality refers to the probability of dying between exact ages 15 and 60 years, measured in deaths per 1,000 persons reaching age 15 years. Observed data on adult mortality are available for an increasing number of countries. In the 2017 Revision of World Population Prospects, for about 80 per cent of countries, adult mortality was estimated on the basis of observed data.

In Africa, adult mortality declined by 23 per cent between 1990 and 2015, while the population aged 15-59 years increased from 319 million to 640 million. In Asia, adult

mortality decreased even more, by 30 per cent between 1990 and 2015 and the population aged 15-59 years grew from 1.9 billion to 2.8 billion. In Latin America and the Caribbean, a 33 per cent decline in adult mortality was also accompanied by an increase of population in that age group. In Northern America, Oceania and Europe, all with lower levels of adult mortality compared to the other regions, the number of people aged 15-59 years changed little between 1990 and 2015.

More than half of all deaths worldwide now occur at older ages

Everyone aspires to live to old age, but, until recently, fewer than half of all people born in the world survived to their sixty-fifth birthday. An increasing percentage of deaths at ages 65 years and over marks significant progress in socioeconomic development and prevention of premature deaths. In 2015, the percentage of deaths at ages 65 years and over reached 55 per cent worldwide, up from around 41 per cent in 1990. This achievement mostly reflects progress in Asia and Latin America and the Caribbean, where the share of deaths at ages 65 and over increased from 38 to 58 per cent and from 40 to 56 per cent, respectively, between 1990 and 2015. In Africa, with lower life expectancy at birth and higher mortality risks at all ages, the percentage of deaths at older ages remains low, at 16 in 1990 and 25 in 2015.

Europe had the highest share of deaths at ages 65 and over with 76 per cent in 2015, rising from 69 per cent in 1990. Europe is followed by Northern America, where the share was around 74 per cent in 1990 and 2015. In Oceania, the share increased from 61 to 69 per cent. Because of the relatively small number of deaths in Oceania, the contribution of this region to the global increase of the percentage of deaths at ages 65 and over was small.

5.6 Mortality trends country wise

As of 2017 the crude **death rate** for the whole **world** is 8.33 per 1,000 (up from 7.8 per 1,000 in 2016) according to the current CIA **World** Factbook. More than 1.25 million people die each year from road traffic accidents, 90 percent of which occur in low- or middle-income **countries**. According to WHO, **causes** of road traffic accidents include unsafe vehicles, inadequate law enforcement, drivers under the influence and speeding. The countries in the world which have the highest mortality rate i.e death per 1000 population are Lesotho (15), followed by Lithuania (14.6), Bulgaria (14.5) and Lativia (14.5). While

Qatar **has** the absolute **lowest death rate** in the world, with 1.53 deaths per 1000 people annually.

Most of the 25,000 children under five that die each day are concentrated in the world's poorest countries in sub-Saharan Africa and South Asia. There, the child mortality rate is 29 times greater than in industrialized countries: 175 deaths per 1000 children compared with 6 per 1000 in industrialized countries.

The major causes of death in the developing world are many. Severe poverty is the root cause of the high mortality rates in the developing world. Poverty results in malnutrition, overcrowded living conditions, inadequate sanitation, and contaminated water.

Environmental and social barriers prevent access to basic medical resources and thus contribute to an increasing infant mortality rate; 99% of infant deaths occur in developing countries, and 86% of these deaths are due to infections, premature births, complications during delivery, and perinatal asphyxia and birth. Afghanistan has the highest infant mortality rate in the world, with 110.6 deaths per 1,000 children 5 years old and younger. Other countries with high infant mortality rates are Somalia (94.8), the Central African Republic (86.3), and Guinea-Bissau(85.7). While on the other hand France's infant mortality rate is among the lowest in the world, at 3.2 deaths per 1,000 live births followed by Cuba (4.4) and United States(5.8).

Japan(0.9) leads the world for lowest new born mortality, according to the latest report by the (UNICEF, 2018), followed by Iceland (1.0), Singapore (1.1), Finland (1.2), Estonia (1.3) and Slovenia (1.3). At the other end of the spectrum, Pakistan(45.6) is the riskiest country to be born in, having the highest new born mortality, with one in 22 babies born there die before they turn one month old. Followed by the Central African Republic (42.3), Afghanistan (40.0) and Somalia (38.8).Each year, some 2.6 million babies do not survive through their first month — an average of 7,000 deaths every day(UNICEF, 2018). Neonatal mortality rate (NMR) is defined as the number of baby deaths per 1,000 live births during the first 28 days of life.

5.7 Determinants of Mortality

The causes of mortality vary both in space and time. Since causes of death are intimately related to the socio-economic and technological background of medical technology and soundness of health services, therefore the causes of mortality vary from one population to another. Broadly the factors responsible for mortality are divided into two categories; - *endogenetic* (biological) and *exogenetic* (environmental) factors.

The *endogenetic* factors are essentially biological in nature, which cause death due to rapid alterations in the functioning of human body. The disease of the circulatory system, the disease that may cause infant mortality and cancer.

The *exogenetic* factors which are environmental in nature comprise environmental influences giving rise to infectious pulmonary and digestive diseases. The environmental conditions which have their link largely with climate (excessive cold, excessive heat) have been found to have adverse effect on the human body. The role of such factors is most prominent in countries, which are at low level of technological advancement.

Broadly speaking, the mortality rate in any population is governed by its age structures, social advancement and economic development. The determinants of mortality may be classified into three basic categories – demographic, social and economic factors.

Demographically, the age structure is most prominent. Other demographic factors like sex composition and degree of urban development are also significant.
Socially, incidence of infanticide, restrictions on widow remarriage, adequacy of medical facilities, general conditions of nutrition, housing and sanitation, literacy standards and religious beliefs are important.

Among the *economic* factors the standard of living or per capita income and type of economy are considered significant.

Besides, the factors like natural calamities, wars, epidemics, food-shortage also cause mortality on a large scale as and when they come.

5.8 Questions

5.9 Key words

Crude birth rate, Age specific death rate, Infant mortality rate, Maternal mortality rate, Abridged and complete Life table.

5.10 Suggested Readings

UNIT-VI
INTRODUCTION TO AGRICULTURAL ECONOMICS

Structure

6.0 Introduction

As a separate discipline, agricultural economics started only in the beginning of 20th century when economic issues pertaining to agriculture aroused interest at several educational institutes. The depression of 1890s that wrecked havoc in agriculture at many places forced organized farmers groups to take keen interest in farm management problems. The study and teaching of agricultural economics was started at Harvard University (USA) in 1903 by Professor Thomas Nixon Carver. Agricultural economics may be defined as the application of principles and methods of economics to study the problems of agriculture to get maximum output and profits from the use of resources that are limited for the well being of the society in general and farming industry in particular.

Agricultural economics, as its title implies is that branch of economics which deals with all aspects of problems related to agriculture. According to Snodgrass and Wallace, "Agricultural economics is an applied phase of the social science of economics in which attention is given to all aspects of problems related to agriculture." Agricultural economics is the study of allocation, distribution, and utilization of the resources used, along with the commodities produced, by farming. Agricultural economics plays a role in the economics of development. It is an applied field of economics concerned with the use of economic theory in optimizing the production and distribution of food and fiber. Agricultural economics takes the tools of both microeconomics and macroeconomics and uses them to solve problems in a specific area.

Prof. Gray treats agricultural economics as a branch of general subject of economics. It is only one of the many branches of applied economics. Such as Industrial Economics, Labour Economics, Monetary Economics, Transport Economics, Public Economics, International Economics, Household Economics, etc. Thus according to Prof. Gray, agricultural economics only a phase of an immense field called economics in which primary attention is paid to the analysis of the economic problems associated with agriculture, Prof. Gray defines agricultural economics, "as the science in which the principles and methods of economics are applied to the special conditions of agricultural industry." No doubt both these definitions are wider in scope, but these are not explanatory and are characterized by vagueness unsettled.

Prof. Hubbard has defined agricultural economics as, "the study of relationship arising from the wealth-getting and wealth-using activity of man in agriculture." This definition is based o Prof. Ely's definition of economics and is mere akin to Marshall's conception of economic activities and therefore it is also limited in scope. According to Lionel Robbins, economics deals with the problems of allocative efficiency i.e. choice between various alternative uses-particularly when resources are scarce to maximize some given ends. Thus it provides analytical techniques for evaluating different allocations of resources among alternative uses Prof. Taylor defines agricultural economics in Robbins tone. To use his words, "Agricultural economics treats of the selection of land, labour, and equipment for a farm, the choice of crops to be grown, the selection of livestock enterprises to be carried on and the whole question of the proportions in which all these agencies should be combined. These questions are treated primarily from the point of view of costs and prices."

Frankly speaking Taylor's definition appears to be a pretty careful definition of farming from the point of view of farm management and therefore is narrow and limited in scope. A similar definition has been furnished by Prof. Jouzier as, "Agricultural Economics is that branch of agricultural science which treats of the manner of regulating the relations of the different elements comprising the resources of the former whether it be the relation to each other or to human beings in order to secure the greatest degree of prosperity".

According to Prof. Edgar Thomas, "Agricultural economics is concerned with farming as a business and with agriculture as an industry. In the more restricted sphere of farm management the student of agricultural economics is concerned with the business problems of the firm of the producing unit of the industries. In the wider sphere of social economics he is concerned with the general economic pattern of the agricultural industry as a whole and with the forces responsible for the moulding of that pattern; he is also concerned with the relation of the agricultural industry to other industries within the national economy as well as with its place in world economy."

According to Prof. Heady, "Agricultural economics is an applied field of science wherein the principles of choice are applied to the use of capital, labour, land and management resources in the farming industries. As a study of resource efficiency, it is concerned with defining the condition under which the ends or objectives of farm manager form families and the nation's consumers can be attained to the greatest degree."

As we know, economic activities are divided into production, exchange, distribution and consumption, agricultural economics cover all of them-what to produce, how to produce, how much to produce, what to sell, where to sell and at what price to sell; what to distribute, among whom to distribute and on what basis to distribute; and what to consume and how much to consume.

Specifically, we can say agricultural economics includes the choice of farming as an occupation, the choice between cultivator and animal husbandry of machinery and labour; combination of various factors of production, intensity of cultivation irrigation, manuring, marketing, soil conservation, land revenues system, costs, prices, wages, profits, finance, credit, employment, etc. In all these cases the fundamental problem before the agricultural economist is to recommend the combination of factors of production in ideal proportion under given conditions in the economic interests of the agricultural community.

According to Prof. Holerow, "Agricultural economics is concerned with the allocation of resources in the agricultural industry, with the alternatives in production, marketing or public policy." Agricultural economists are concerned with the study of efficiency in farm

production, with the returns that will result from employing various quantities and combinations of inputs in farming, and with determining the best farm production alternatives under given physical and economic conditions. They are concerned with the economics of agricultural markets, with the costs of marketing various farm products, and with the alternative steps or changes that may made in the marketing structure to serve the objectives of society more efficiently. They are interested in analysis of the alternatives in public policy and the economic effects of carrying out a particular programme, such as price support law or a soil conservation programme.

6.1 Objectives

To study the nature of Agricultural Economics
To understand the Interdependence and complementarities between agriculture and industry
To study the relationship between Agriculture, poverty and environment
To study the various types of Farming Systems
To understand the relationship between Farm size and practices
To study the Farm efficiency measure
To study the Resource management in agriculture

6.2 Nature of Agricultural Economics

The foregoing definitions indicate the scope of agricultural economics as given in the introduction section. A common theme of scarcity of resources and choice of uses runs almost through all of these definitions. That way, agricultural economics is not different from the general economics.

All the tools of analysis used in general economics are employed in agricultural economics as well. We have the same branches of agricultural economics i.e. economics of production, consumption, distribution, marketing, financing and planning and policy making as in case of general economics. A study at the micro and macro level for the agricultural sector is also generally made. Static and dynamic analyses are also relevant for the agricultural sector of the economy.

To be more specific, these definitions point out that agricultural economics examines how a farmer chooses various process e.g., production of crops or rising of cattle and how he chooses various activities in the same enterprise. E.g., which crop to grow and which crop to drop; how the costs are to be minimized; what combination of inputs for an activity are to be

selected; but amount of each crop is to be produced but type of commercial relation the farmer have to have with people from whom they purchase their input or to whom they sail their product.

Agricultural economics does not study only the behavior of a farmer at the farm level. That is, in a way, the micro analysis. Agricultural problems have a macro aspect as well. Instability of agriculture and agricultural unemployment are the problems which have to be dealt with, mainly at the macro level. And then, there are the general problems of agricultural growth and the problems like those concerning tenurial systems and tenurial arrangements, research and extension services which are again predominantly macro in character. Such problems their origin, their impact and their solutions are the entire subject matter of agricultural economics.

The scope of agricultural economics is larger than 'mere economizing of resources'. Agriculture is, as we know an important sector, of the overall economy. The mutual dependence of the various sectors of the economy on each other is well established. Growth of one sector is necessary for the growth of the other sector.

As such, in agricultural economics, we also study how development of agriculture helps the development of the other sectors of the economy; how can labour and capital flow into the non-agricultural sectors; how agricultural development initiates and sustains the development of other sectors of the economy.

What this implies is that agricultural economics not only develops concerning the use of scarce resources in agriculture properly but also examines the principles (a) regarding the out flow of scare resources to other sectors of the economy and (b) about the flow of these resources from other sectors into the agricultural sector itself.

Check your Progress/ Self Assessment Questions

What are the two main principles the agricultural economics generally examines?

6.3 Interdependence and Complementarities between Agriculture and Industry

The interdependence of agriculture and industry helps the development of both the sectors. The most important aspect of this interdependence is that the products of one serve as important inputs for the other. Growth of one sector thus means ample supply of inputs for the other. The situation is such that a greater flow of products from one sector to other simultaneously ensures a greater return flow of inputs itself, though with some time lag. Help others to help you in brief, sums up, development.

6.3.1 Contributions of Agriculture to Industry:

A. Supply of raw materials to industries: Many industries look to the agricultural sector for supply of raw material.

B. Supply of wage goods: The market arrivals of food grains can be taken to represent what agriculture can spare for the non-agricultural sector as wage goods provided the market arrivals do not contain any distress sale on the part of the agriculturists. With this provision in view, we give below the market arrivals in the state of Punjab for the last 30 years or so.

Punjab agriculture has developed at a much rapid pace as compared with that in the other states of the country and its rate of growth of population is one of the lowest in the country. So, there is a reason to believe that whatever is sold in the market is a genuine surplus spared by the agricultural sector.

C. Agriculture and foreign trade: Though India has been importing food grains for quite sometimes after independence, it has also been exporting the products of Argo-based industries, thereby, helping the country, not only to pay for the food imports but also for other imports which includes capital goods also. It is important to note here that the major traditional exports of India are the cotton textiles, Jute textiles and tea.

D. Provision of market for the industrial sector: The increasing income of the farm sector leads to an expanded demand for the consumer's goods produced in the industrial sector. Though no enquiry directly pertaining to this issue has been conducted in India, the data collected by the National Sample Survey organization does indicate that the goods produced in the industrial sector are finding their way into the consumption schedule of the rural people.

E. Provision of capital and labour to the non-agricultural sector: No data are available about the supply of these to inputs by the agricultural sector to the industrial sector. Since it is the agriculture which is the custodian of capital and labour in the initial stages of economic development, it can be positively asserted that, these factors have moved to the industrial sector, mainly from the agricultural sector, in initial stages of economic development in most of the countries.

The contribution of the agriculturists in setting up of various industries in England, of textile industry in India and of some important industries in Japan is quite known. The statement about Indian labour that it was migratory in character and that this was because of its nexus with agriculture shows that it was agricultural sector which provided labour to the industrial sector in the initial stages of the development of the latter.

6.3.2 Contributions of the Industry to agriculture:

A. Provision of modern inputs to the agricultural sector: One of the major contributions of the industrial sector is to provide modern input to agriculture. The inputs are in the form of fertilizers, pesticides, machinery etc.

B. Reduction of population pressure on land: Data regarding transfer of population from agricultural to non agricultural sector in India does not yield an encouraging picture. Dependence of population on agriculture during the last 50 years or so has not declined to any significant extent.

Growing population and a slow progress of the industrial sector are responsible for this static situation. However, the population data concerning some developed countries of Europe & that of the U.S.A., are quite illuminating in this regard.

C. Provision of infrastructure: No doubt, many of the items included infrastructure serve the agricultural sector as well as the industrial sector but these are provided mainly by the industrial sector. Transport, electricity, financial institutions, health services, educational and research institutions, all owe their existence mainly to the facilities provided by the industrial sector.

Check your Progress/ Self Assessment Questions

The interdependence of agriculture and industry helps in the development of which sector?

6.4 Agriculture, Poverty and Environment

The first and the foremost Sustainable Development Goal is to End Poverty in all forms everywhere. Each and every country of the world is looking forward to eradicating poverty so that even the poor and vulnerable people also enjoy equal rights to economic resources, healthy living conditions as well as access to basic infrastructure and technology. Moreover, there should not be any doubt that poor nations and poor people are more severely vulnerable to effects of environmental damage than the rich. Over the past few decades, average living standards have risen and the gap between the very rich and the very poor has broadened. But the question here arises “Why is poverty still prevailing in the world?” There can be many reasons but two biggest factors contributing to poverty are:

A. Lack of education and improper implementation of poverty eradication policies at the grass-root level. More often than not, many international reports claim that poverty contributes to environmental degradation.

B. Due to lack of sufficient resources and improper knowledge poverty-stricken people tend to overuse every resource available to them when their survival is at stake. But generally, we

tend to forget that poor people are the most undefended ones when it comes to the effects of environmental pollution, climate change and global warming.

It is very important for everyone to recognize that poverty and environmental issues are interrelated. Poverty among people puts stress on the environment whereas environmental problems cause severe suffering to the poor. People, whether they be rich or poor, consume water, food, and natural resources in order to remain alive. All economic activities are directly, indirectly or remotely based on natural resources and any pressure on natural resources can cause environmental stress. Environmental damage can prevent people, especially the poor, from having good and hygienic living standards. As poor people rely more directly on the environment than the rich for their survival, they are mostly on the receiving end of environmental problems

Poverty often causes people to put relatively more pressure on the environment which results in larger families (due to high death rates and insecurity), improper human waste disposal leading to unhealthy living conditions, more pressure on fragile land to meet their needs, overexploitation of natural resources and more deforestation. Insufficient knowledge about agricultural practices can also lead to a decline in crop yield and productivity etc.

On the other hand environmental problems add more to the miseries of poor people. Environmental problems cause more suffering among them as environmental damage increases the impact of floods and other environmental catastrophes. Soil erosion, land degradation and deforestation lead to a decline in food production along with a shortage of wood for fuel contribute to inflation. In short, the worst consequences of environmental deterioration, whether they are economical, social, or related to mental or physical wellbeing, are experienced by poor people.

More rigorous efforts should be undertaken by the governments of all countries to eradicate poverty and in turn, to save deprived people from the dreadful implications of environmental damage. There should be more collaborative partnerships among all sections of the society so that even the people living in poverty are linked to the world through their participation in social, political, and economical spheres along with their active participation in environmental regeneration.

6.4.1 Causes of Poverty

Different studies have shown that poverty is caused by a number of factors such as economic, social, political and environmental

Economic Factors • Low productivity • Lack of skills • Lack of economic policies • Economic shocks • Terms of trade • Technological backwardness • Effect of Globalization	Social Factor • Discrimination • Poor health situation • Inequality • Lack of capital • Culture of poverty
Political Factors • Bad Governance • Insecurity • Violent conflict • Domination by regional/ global superpowers • Globalization	Environmental • Low quality natural resources • Environmental degradation • Disasters • Remoteness and lack of access • Propensity for disease

6.4.2 Poverty and Agriculture

Being an agricultural country, agriculture has dominant role to play in India. But vicious circle of poverty exists in Indian agriculture. The low graded and least productive activities occupied by the poor and that too, in small patches and insufficient amount, subsistence agriculture and low capacity to invest to increase productivity due to low income level etc are the main causes of the vicious circle of poverty existing in agriculture sector. A large majority of households depends upon agriculture and allied activities such as livestock-rearing and forest production collection. Beside this, low economic growth, low social and economic infrastructure, a relatively high population growth, low access to non-agricultural income and deep –rooted cultural practices are the major causes of poverty in India. Degradation of environment through deforestation, soil erosion and landslides is already affecting significantly the livelihood of the poor people specially life of women and children.

Check your Progress/ Self Assessment Questions

What is the first and foremost goal of sustainable development?

What are the main factors responsible for poverty?

6.5 Farming Systems

Farming system is an appropriate mix of farm enterprises and the technique available to the farmers to raise them for profitability. It interacts adequately with environment without dislocating the ecological and socio-economic balance on one hand and attempt to meet the national goal on the other. In its real sense it will help in lifting the economy of agriculture and standard of living of the farmers of the country as a whole.

Farming system is a resource management strategy to achieve economic and sustained agricultural production to meet diverse requirements of farm livelihood while preserving resource base and maintaining a high level of environment quality.

Farming system is a set of agro economic activities that are interrelated and interact with themselves in a particular agrarian setting. It is a mix of farm enterprises to which farm families allocate its resources in order to efficiently utilize the existing enterprises for increasing the productivity and profitability of the farm. These farm enterprises are crop, livestock, aquaculture, agro forestry and agri-horticulture.

Farming system is a mix of farm enterprises such as crop, livestock, aquaculture, agro forestry and fruit crops to which farm family allocates its resources in order to efficiently manage the existing environment for the attainment of the family goal.

6.5.1 Specialized v/s Integrated Farming System:

6.5.1.1 Specialized Farming System (SFS): Specialization involves the intensification of the agricultural activity aimed at maximization of the production/area/time. This involves improvement of operational efficiency and speed of operation/execution operation/ execution at each step. The specialized farming system is focused on single cropping system or sequence of farming enterprise like animal breeding, dairying so as to achieve the highest degree of precision management with minimal diversion of resources/attention to diverse crops or enterprises.

6.5.1.2 Integrated Farming System (IFS): IFS, a component of FSR (Farming System research), introduces a change in the farming techniques for maximum production in the cropping pattern and takes care of optimal utilization of resources. The farm wastes are better recycled for productive purposes in the IFS. Unlike the SFS, IFS's activity is focused round a few selected, interdependent, interrelated and often interlinking production systems based on a few crops, animals and related subsidiary professions. IFS envisage harnessing the

complementarities and synergies among different agricultural sub-systems/enterprises and augmenting the total productivity, sustainability and gainful employment.

6.5.2 Scope of Farming System:

Farming enterprises include crop, livestock, poultry, fish, sericulture etc. A combination of one or more enterprises with cropping when carefully chosen, planned and executed gives greater dividends than a single enterprise, especially for small and marginal farmers. Farm as a unit is to be considered and planned for effective integration of the enterprises to be combined with crop production activity.

Check your Progress/ Self Assessment Questions

What are the things include in farming enterprises?

6.6 Farm Size and Practices

Even today, agriculture is an important source of income and the world's largest business. One-third of the economically active population obtains its livelihood from agriculture. In Asia and Africa, millions of small-scale and subsistence farmers, pastoralists, fishermen and indigenous peoples produce most of the food consumed worldwide, in most cases on very small plots of land. Over the past decades, agricultural policy and international institutions, as well as private and public agricultural research have often considered small-scale and subsistence farmers as backward "phase-out models" of a pre-industrial form of production. For more than 50 years, "grow or die" has been both the capitalist and socialist principle for progress, with just a few exceptions. The widely held belief was that only large economic units were capable of achieving increases in productivity on a competitive basis through modern and rationalized cultivation methods, mainly with chemical inputs and the use of machinery. A global increase in productivity was considered necessary to feed a rapidly growing world population.

Globally, in both poor and rich countries, agriculture is one of the few industries that remain largely owner-operated and reliant on family labour. Family farms typically achieve a high degree of efficiency, benefitting from the commitment of family workers, a flexible labour supply to cope with seasonal and annual variability of production, and an intimate knowledge about local soil and climate. In some countries, however, the limited success of smallholder-based efforts to improve productivity, among other factors, has led to policies that promote large-scale mechanized farming. Many crop-based farms in developing and transitional countries have operational units that exceed 10,000 hectares often

further horizontally integrated into “super farms” that control hundreds of thousands of hectares.

Check your Progress/ Self Assessment Questions

What was considered as necessary to feed a rapidly growing world population?

6.7 Farm Efficiency Measures

An important element in farm business management or decision making relates to the manner in which available resources are allocated vis-à-vis the objectives of the farmer.

A "measuring stick" is necessary to provide guides and standard for appraising accuracy of decisions regarding the use of resources. One method of production is said to be more efficient than the other when it yields a greater valuable output per unit of a valuable input. From an economic stand point, efficiency is desirable and the science of farm management deals with such principles and theories of farm business organization which are instrumental in increasing the efficiency of the business.

Efficiency can be related to (1) the operation of the farm business as a whole, (2) any individual phase of the business, line of production or enterprise (dairy, poultry, wheat, cotton, sugarcane, maize, etc.).

Various efficiency measures, therefore, need to be developed to express technical efficiency in various farm enterprises and to relate these to the financial success.

The various farm efficiency measures can be discussed as:

(I) Physical efficiency measures (Physical Efficiency) and

(II) Value efficiency measures (Financial Efficiency).

They can be further categorized as: (I) Ratio measures and (II) Absolute or aggregate measures.

A brief description of some of the farm efficiency measures is given below:

A. Total Area of the Farm

The first measure of size is the acreage of the farm: either or total land or land under crops. This is a fairly satisfactory measure for comparing a given type of land and a given type of farming. Average area per farm varies from region to region and the combination of enterprises also varies from good to poor soil and from humid to arid climates. One can consider number of standard acres under such situations and compare the size of farms.

B. Land Use Efficiency

Some of the measures or indices measuring the rate of production are:

i. Yield per acre (production efficiency). The production efficiency of a farm with respect to any particular crop enterprise can be expressed in terms of percentage as compared with average yield of the locality.

ii. Crop yield index. It is a measure of comparison of the yield of all crops on a given farm with the average yields of these crops in the locality. The relationship is expressed in percentage terms. This yield index is a convenient measure because it combines all the yields into a single figure.

C. Intensity of cropping

It measures the extent of the use of land for cropping purposes during a given year. It is expressed as a percentage.

D. Labour Efficiency Measures

By comparing the labour efficiency we can know whether the labour on a farm is more or less than what is required. We can also find out whether the labour is relatively more or less efficient.

i. Crop acreage per man equivalent

The significance of this measure is influenced by the varying proportion of crops with high or low labour requirements, such as potatoes compared with wheat. It is one of the simplest measures and is computed by dividing the total acres in crops by man-equivalents.

ii. Productive man-work units per man-equivalent

It is another good and accurate general measure of labour efficiency for all types of farms. This measure is computed by dividing total productive man-work units by the number of man-equivalents on the farm.

E. Cost Ratios

Most of the ratios or efficiency factors discussed up to this point are needed in the process of analysis of the records. Their purpose, in general, is to indicate a strong or weak point in the organization or operation of the business and to call attention to the specific phases or angles of the business where greater managerial attention is needed. In addition, there are other ratios that are often used in a more general analysis. They deal with the relationship between costs and returns, relationship of capital investment to income, and the rate of activity or turnover of the capital. Cost ratios are averages and their magnitudes reflect

physical production efficiency, selection of enterprises, prices received for commodities and the expense for the production elements. These cost ratios are discussed below:

i. Operating cost ratio

The operating ratio is the percentage which operating expenses absorb out of gross profit. It shows the proportion of total income used in (1) hiring labour (2) buying seeds, fuel and other annual supplies and (3) in keeping equipment in operation, etc.
It is computed by dividing total operating expenses by gross profit and can be expressed as a percentage or a ratio.

ii. Over-head charges (Fixed Ratio)

Fixed expenses continue in about the same amount regardless of the current operating policy. Their relative importance in production can be expressed by a ratio determined by dividing the total fixed costs by the gross profits.

F. Capital Ratios

Capital ratios can also be used in the analysis of the organization with respect to the resources of the farm.

a. Capital per unit of Gross Income: Occasionally a ratio is computed to measure the total amount of capital invested per unit of gross income = Total capital invested gross income

b. Capital per man: The ratio of capital per man indicates the combination of resources in a general way. It is ordinarily computed by dividing the total capital by the number of man-year equivalents employed on the farm. An optimum ratio will vary depending on the kind of farming and the availability of funds. It does not adequately reflect variations which can be possible through capital labour substitution.

c. Rate of capital turnover: It is most common measure of capital efficiency. It is the ratio of the total farm income to the farm capital (total farm assets).

Rate of capital turn over = Gross Income x 100

Check your Progress/ Self Assessment Questions

What are the two measures to calculate farm efficiency?

6.8 Resource Management in Agriculture

Natural Resources are very important for the development of our country. All the living things are dependent on natural resources directly or indirectly. Without the natural

resources the living things cannot survive. There are different types of natural resources from which living things are getting benefit like Timber, wood etc from the forest resources, irrigation water, drinking water from water resources, minerals for the industry development.

Other resources like solar energy, wind energy, tidal energy play a very important role in our daily life. Fossil fuels such as Natural Gas, Coal, and Petroleum are the resources which are used in day to day life.

Natural resources play a very important role in every sector of the national economy like in industry, **agriculture**, transport, commercial and domestic needs. Natural resources also play a vital role in the economic development by increasing agriculture trade which is imported and exported to the other countries, this type of products the available in our country also attract the foreign investors. Natural resources are very important so that environment will be in balance. If we continuously misuse or over use the natural resources like water, fuel, minerals, soil etc, it can affect the environment and all living things. All the things we need in our daily life that such as food, water, air, fuel comes from natural resources. Natural resources provide every daily needs of human like shelter, food, clothes etc.

6.8.1 Main strategies of Natural Resource Management

- Adoption of integrated approach for the treatment of degraded area as cluster and contiguous manner;
- Integration of sectoral measures for comprehensive development and maintenance of ecology of the areas;
- Consolidation of treatment efforts through projectised approach with proper choice of treatment measures,
- Emphasis on sustainability of treatment measures to address various issues relating to climate change;,
- Construction of strategically located structures, along drainage line treatment measures to check/reduce velocity of runoff and in-situ conservation of natural resources; and
- Multi-disciplinary approach involving various line departments like Agriculture, Forests, Horticulture, Animal Husbandry, Minor Irrigation etc. at the district and project level while developing programme measures and implementation etc.

Check your Progress/ Self Assessment Questions

What are the types of natural resources?

6.9 Let us sum up

The present unit gives us idea regarding the nature of agricultural economics. It explained about the interdependence and complementarities between agriculture and industry with the help of two topics i.e., contributions of agriculture to industry and contributions of the industry to agriculture. In this unit also gives us idea regarding the relationship between agriculture, poverty and environment along with the main causes of poverty. We have also discussed about the farming systems with special reference to specialized and integrated farming system along with the scope of farming system. We have explained about farm size and practices. Finally the unit gives us idea regarding the farm efficiency measure along with resource management in agriculture.

6.10 Key Terms

Farming system: It is a mix of farm enterprises such as crop, livestock, aquaculture, agro forestry and fruit crops to which farm family allocates its resources in order to efficiently manage the existing environment for the attainment of the family goal.

Specialized Farming System (SFS): Specialization involves the intensification of the agricultural activity aimed at maximization of the production/area/time. This involves improvement of operational efficiency and speed of operation/execution operation/ execution at each step. The specialized farming system is focused on single cropping system or sequence of farming enterprise like animal breeding, dairying so as to achieve the highest degree of precision management with minimal diversion of resources/attention to diverse crops or enterprises.

Integrated Farming System (IFS): IFS, a component of FSR (Farming System research), introduces a change in the farming techniques for maximum production in the cropping pattern and takes care of optimal utilization of resources. The farm wastes are better recycled for productive purposes in the IFS. Unlike the SFS, IFS's activity is focused round a few selected, interdependent, interrelated and often interlinking production systems based on a few crops, animals and related subsidiary professions. IFS envisage harnessing the

complementarities and synergies among different agricultural sub-systems/enterprises and augmenting the total productivity, sustainability and gainful employment.

Farm Efficiency Measures: An important element in farm business management or decision making relates to the manner in which available resources are allocated vis-à-vis the objectives of the farmer.

6.11 Answer to 'Check Your Progress'

Q. What are the two main principles the agricultural economics generally examines?
A. The two main principles that agricultural economics generally examines are:
(a) Regarding the out flow of scare resources to other sectors of the economy and (b) About the flow of these resources from other sectors into the agricultural sector itself.
Q. Interdependence of agriculture and industry helps in the development of which sector?
A. The interdependence between agriculture and industry will be helpful for the development of both the sectors.
Q. What is the first and foremost goal of sustainable development?
A. The first and the foremost goal of sustainable development is to End Poverty in all forms everywhere.
Q. What are the main factors responsible for poverty?
A. The main factors responsible for poverty are economic, social, political and environmental.
Q. What are the things include in farming enterprises?
A. Farming enterprises include crop, livestock, poultry, fish, sericulture etc.
Q. What was considered as necessary to feed a rapidly growing world population?
A. Global increase in productivity was considered necessary to feed a rapidly growing world population.
Q. What are the two measures to calculate farm efficiency?
A. The two measures are Physical efficiency measures (Physical Efficiency) and Value efficiency measures (Financial Efficiency).
Q. What are the types of natural resources?
A. Various types of natural resources are forest, water, minerals, solar energy, wind energy, tidal energy, fossil fuels, etc.

6.12 Questions and Answers

6.12.1 Short-Answer Questions

Q. Define farming system

A. Farming system is a mix of farm enterprises such as crop, livestock, aquaculture, agro forestry and fruit crops to which farm family allocates its resources in order to efficiently manage the existing environment for the attainment of the family goal.

Q. What are the two main reasons for poverty in the world?

A. The two main reasons for poverty in the world are as follows:

1. Lack of education and improper implementation of poverty eradication policies at the grass-root level. More often than not, many international reports claim that poverty contributes to environmental degradation.

2. Due to lack of sufficient resources and improper knowledge poverty-stricken people tend to overuse every resource available to them when their survival is at stake. But generally, we tend to forget that poor people are the most undefended ones when it comes to the effects of environmental pollution, climate change and global warming.

6.12.2 Long-Answer Questions

Q. Explain the major contributions of agricultural sector to industrial sector?

A. The major contributions are:

1. Supply of raw materials to industries: Many industries look to the agricultural sector for supply of raw material.

2. Supply of wage goods: The market arrivals of food grains can be taken to represent what agriculture can spare for the non-agricultural sector as wage goods provided the market arrivals do not contain any distress sale on the part of the agriculturists. With this provision in view, we give below the market arrivals in the state of Punjab for the last 30 years or so.

Punjab agriculture has developed at a much rapid pace as compared with that in the other states of the country and its rate of growth of population is one of the lowest in the country. So, there is a reason to believe that whatever is sold in the market is a genuine surplus spared by the agricultural sector.

3. Agriculture and foreign trade: Though India has been importing food grains for quite sometimes after independence, it has also been exporting the products of Argo-based industries, thereby, helping the country, not only to pay for the food imports but also for other imports which includes capital goods also. It is important to note here that the major traditional exports of India are the cotton textiles, Jute textiles and tea.

4. Provision of market for the industrial sector: The increasing income of the farm sector leads to an expanded demand for the consumer's goods produced in the industrial sector. Though no enquiry directly pertaining to this issue has been conducted in India, the data collected by the National Sample Survey organization does indicate that the goods produced in the industrial sector are finding their way into the consumption schedule of the rural people.

5. Provision of capital and labour to the non-agricultural sector: No data are available about the supply of these to inputs by the agricultural sector to the industrial sector. Since it is the agriculture which is the custodian of capital and labour in the initial stages of economic development, it can be positively asserted that, these factors have moved to the industrial sector, mainly from the agricultural sector, in initial stages of economic development in most of the countries.

Q. Explain the major contributions of industrial sector to agricultural sector?

A. The major contributions are:

1. Provision of modern inputs to the agricultural sector: One of the major contributions of the industrial sector is to provide modern input to agriculture. The inputs are in the form of fertilizers, pesticides, machinery etc.

2. Reduction of population pressure on land: Data regarding transfer of population from agricultural to non agricultural sector in India does not yield an encouraging picture. Dependence of population on agriculture during the last 50 years or so has not declined to any significant extent.

3. Provision of infrastructure: No doubt, many of the items included infrastructure serve the agricultural sector as well as the industrial sector but these are provided mainly by the industrial sector. Transport, electricity, financial institutions, health services, educational and

research institutions, all owe their existence mainly to the facilities provided by the industrial sector.

Q. Explain the various causes of poverty.

A. various causes of poverty are:

1. Economic Factors: Low productivity, lack of skills, lacks of economic policies, economic shocks, terms of trade, technological backwardness and effect of globalization.

2. Social Factor: Discrimination, poor health situation, inequality, lack of capital and culture of poverty.

3. Political Factors: Bad governance, insecurity, violent conflict, domination by regional/ global superpowers and globalization.

4. Environmental: Low quality natural resources, environmental degradation, disasters, remoteness and lack of access and propensity for disease.

Q. Explain the relationship between Poverty and Agriculture.

A. Being an agricultural country, agriculture has dominant role to play in India. But vicious circle of poverty exists in Indian agriculture. The low graded and least productive activities occupied by the poor and that too, in small patches and insufficient amount, subsistence agriculture and low capacity to invest to increase productivity due to low income level etc are the main causes of the vicious circle of poverty existing in agriculture sector. A large majority of households depends upon agriculture and allied activities such as livestock-rearing and forest production collection. Beside this, low economic growth, low social and economic infrastructure, a relatively high population growth, low access to non-agricultural income and deep –rooted cultural practices are the major causes of poverty in India. Degradation of environment through deforestation, soil erosion and landslides is already affecting significantly the livelihood of the poor people specially life of women and children.

Q. Explain the relationship between farm size and practices

A. Even today, agriculture is an important source of income and the world's largest business. One-third of the economically active population obtains its livelihood from agriculture. In Asia and Africa, millions of small-scale and subsistence farmers, pastoralists, fishermen and indigenous peoples produce most of the food consumed worldwide, in most cases on very

small plots of land. Over the past decades, agricultural policy and international institutions, as well as private and public agricultural research have often considered small-scale and subsistence farmers as backward "phase-out models" of a pre-industrial form of production. For more than 50 years, "grow or die" has been both the capitalist and socialist principle for progress, with just a few exceptions. The widely held belief was that only large economic units were capable of achieving increases in productivity on a competitive basis through modern and rationalized cultivation methods, mainly with chemical inputs and the use of machinery. A global increase in productivity was considered necessary to feed a rapidly growing world population.

Q. What are the main strategies of natural resource management?

A. The main strategies of natural resource management are:

1. Adoption of integrated approach for the treatment of degraded area as cluster and contiguous manner;
2. Integration of sectoral measures for comprehensive development and maintenance of ecology of the areas;
3. Consolidation of treatment efforts through projectised approach with proper choice of treatment measures,
4. Emphasis on sustainability of treatment measures to address various issues relating to climate change;
5. Construction of strategically located structures, along drainage line treatment measures to check/reduce velocity of runoff and in-situ conservation of natural resources; and
6. Multi-disciplinary approach involving various line departments like Agriculture, Forests, Horticulture, Animal Husbandry, Minor Irrigation etc. at the district and project level while developing programme measures and implementation etc.

6.13 Further Reading/ Suggested Readings

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Unit- VII
ISSUES IN FARM MANAGEMENT

Structure

7.0 Introduction

In order to appreciate the principles of farm management, it is important to first of all understand what a farm is and then the concept of management. Basically a farm is an economic unit (firm) where inputs are transformed into outputs through an interaction between natural and man-made factors. A combination of inputs also called productive resources or factors of production are usually employed in various proportions using the managerial acumen of the operator of the business who may be called a manager. That is the dynamics of the farm as an economic unit.

The process of organizing and coordinating personnel, materials and processes in an organization towards the achievement of the organization goals is termed management. The subject branches into various fields’ application according to organizational peculiarities. One of such areas of application of the concept of management is in the operation of farm business.

There are different definitions of farm management. However it is pertinent to note that Farm management is mainly concerned with the decisions which affect the objective function of the farm business. A cardinal objective function of farm management is that of profit maximization especially in the case of commercial farms. If the farmer wants to run his farm as an economic entity, his aim should be to produce output which the total value exceeds the total value of input used. This results in profit for the farm. On the other hand, there will be loss if the total value of the inputs is higher than the total value of the output. The total value of the output in financial terms is called “Gross Revenue” (Total Revenue) while the total value of all inputs utilized is called the total cost of production. Farm management can be thought of as being a decision making process, it is a continual process because of the continual changes taking place in the economy, and in an individual agri-business. The decisions are concerned with allocating the limited resources of land, labour and capital among alternative and usually, competing uses. This allocation process forces the farm manager to identify goals and objectives to guide and direct decision making in the

farm. Here we shall adopt the definition, that: “Farm management is a decision-making process in which the available but limited production resources are allocated to selected production alternatives, so as to operate the farm business in such a way as to attain some set objectives”.

7.1 Objectives

- To study the nature of agricultural production function: Cobb-Douglas & Spillmans.
- To understand the risk and uncertainty in agricultural production and prices.
- To study the decision theory.
- To study the Cobweb theorem and Nerlove's model.
- To understand the concept of agricultural marketing.
- To study about marketed and marketable surplus.
- To study Mathur-Eizkel hypothesis.
- To analyze the relationship between farm size and productivity.
- To study concept of pricing policy including support price

7.2 Nature of Agricultural Production Function: Cobb-Douglas

The Cobb-Douglas Production Function, given by Charles W. Cobb and Paul H. Douglas is a linear homogeneous production function, which implies, that the factors of production can be substituted for one another up to a certain extent only.

With the proportionate increase in the input factors, the output also increases in the same proportion. Thus, there are constant returns to a scale. In Cobb-Douglas production function, only two input factors, labor, and capital are taken into the consideration, and the elasticity of substitution is equal to one. It is also assumed that, if any, of the inputs, is zero, the output is also zero.

Likewise, in the linear homogeneous production function, the expansion path generated by the cobb-Douglas function is also a straight line passing through the origin. The CD function can be expressed as follows:

$Q = AL^{\alpha}K^{\beta}$

Where, Q = output

A = positive constant

K = capital employed

L = Labor employed

α and β = positive fractions shows the elasticity coefficients of outputs for inputs labor and capital, respectively.

$\beta = 1-\alpha$

This algebraic form of Cobb-Douglas function can be changed in a log linear form, with the help of regression analysis:

$\text{Log } Q = \log A + \alpha \log L + \beta \log K$

The homogeneity of the Cobb-Douglas production function can be checked by adding the values of α and β. If the sum of these parameters is equal to one, then it shows that the production function is linearly homogeneous, and there are constant returns to a scale. If the sum of these parameters is less or more than one, then there is a decreasing and increasing returns to a scale respectively.

7.2.1 Criticisms of C-D Production Function

The C-D production function has been criticized on the following ground:

A. The C-D production function considers only two inputs, labour and capital, and neglects some important inputs, like raw materials, which are used in production. It is, therefore, not possible to generalize this function to more than two inputs.

B. In the C-D production function, the problem of measurement of capital arises because it takes only the quantity of capital available for production. But the full use of the available capital can be made only in periods of full employment. This is unrealistic because no economy is always fully employed.

C. The C-D production function is criticised because it shows constant returns to scale. But constant returns to scale are not an actuality, for either increasing or decreasing returns to scale are applicable to production.

It is not possible to change all inputs to bring a proportionate change in the outputs of all the industries. Some inputs are scarce and cannot be increased in the same proportion as abundant inputs. On the other hand, inputs like machines, entrepreneurship, etc. are indivisible. As output increases due to the use of indivisible factors to their maximum capacity, per unit cost falls.

Thus when the supply of inputs is scarce and indivisibilities are present, constant returns to scale are not possible. Whenever the units of different inputs are increased in the production process, economies of scale and specialization lead to increasing returns to scale.

In practice, however, no entrepreneur will like to increase the various units of inputs in order to have a proportionate increase in output. His endeavour is to have more than proportionate increase in output, though diminishing returns to scale are also not ruled out.

D. The C-D production function is based on the assumption of substitutability of factors and neglects the complementarity of factors.

E. This function is based on the assumption of perfect competition in the factor market which is unrealistic. If, however, this assumption is dropped, the coefficients α and β do not represent factor shares.

F. One of the weaknesses of C-D function is the aggregation problem. This problem arises when this function is applied to every firm in an industry and to the entire industry. In this situation, there will be many production functions of low or high aggregation. Thus the C-D function does not measure what it aims at measuring.

7.2.2 It's Importance

Despite these criticisms, the C-D function is of much importance.

A. It has been used widely in empirical studies of manufacturing industries and in inter-industry comparisons.

B. It is used to determine the relative shares of labour and capital in total output.

C. It is used to prove Euler's Theorem.

D. Its parameters α and β represent elasticity coefficients that are used for inter-sectoral comparisons.

E. This production function is linear or homogeneous of degree one which shows constant returns to scale, If $\alpha + \beta = 1$, there are constant return to scale, if $\alpha + \beta > 1$, there are increasing returns to scale and if $\alpha + \beta < 1$, there are diminishing returns to scale.

F. Economists have extended this production function to more than two variables.

7.2.3 Conclusion: Thus the practicability of the C-D production function in the manufacturing industry is a doubtful proposition. This is not applicable to agriculture where for intensive cultivation, increasing the quantities of inputs will not raise output proportionately. Even then, it cannot be denied that constant returns to scale are a stage in the life of a firm, industry or economy. It is another thing that this stage may come after some time and for a short while.

Check your Progress/ Self Assessment Questions

What is the nature of Cobb-Douglas production function?

Express the CD production function.

How the homogeneity of the CD production function can be checked?

7.3 Nature of Agricultural Production Function: Spillmans

The Spillman production function is an exponential-type function which allows for diminishing marginal returns. It has been used in agricultural studies to represent crop response to nutrient inputs and diminishing returns in the fattening of livestock. The production surface can be represented by a smooth s-shaped curve which reaches a yield plateau, given appropriate .parameter values. The function increases at an increasing rate, reaches an inflection point after which it increases at a decreasing rate until it reaches a plateau, indicating the maximum value of the function.

The Spillman function has the form:

$Y = \beta_1 (1-\beta_2\beta_3^{X1})(1-\beta_4\beta_5^{X2})$

The Spillman function is not globally regular. However, it is locally regular when $\beta_1 > 0$, $0 < \beta_2 < 1$, $0 < \beta_3 < 1$, $0 < \beta_4 < 1$ and $0 < \beta_5 < 7$. Notice that β_1 represents the maximum obtainable output since the 1imit as X_1 and X_2 go to infinity is β_1 when the function is well behaved.

Check your Progress/ Self Assessment Questions

What is the nature of Spillman production function?

When Spillman production function remain locally regular?

7.4 Risk and Uncertainty in Agricultural Production and Prices

Change and the uncertainty that results are not new to agriculture. However, the rate of change appears to be accelerating which is creating uncertainties that agribusiness have little experience in managing. For example, biotechnology and genetic engineering have reduced the time lapse from trait identification to commercialization in corn genetics from about 12 years to almost 7 years. There has been rapid consolidation and restructuring of the food retailing, chemical manufacturing and the retail input supply industries. The rate of adoption and diffusion of new technologies such as biotechnology is much more rapid than in the past. These dramatic changes are creating new and different risks than traditional operational and financial risks (price, cost, financing, legal, etc.) agribusinesses have faced in the past. As agriculture becomes more industrialized, strategic risk and uncertainty is likely

to become increasingly more important, and as we will note this uncertainty is typically more difficult to manage.

7.4.1 Strategic vs. Tactical Risk with Uncertainty

Strategic risk and uncertainty is the sensitivity of the company's value to inappropriate strategic choices, ineffective strategy implementations, or uncertainties in the business climate. These uncertainties include:

A. Political, government policy, macro-economic, social and natural contingencies, and

B. Industry dynamics involving input markets, product markets, competitive and technological uncertainties. Strategic risk and uncertainty might be characterized as having a low or even unknown probability of loss, but if a loss does occur the consequence could be catastrophic – maybe even threatening the survival of the business. Tactical or operational risk is easier to manage than strategic risk and uncertainty, in part because most strategic risks cannot be managed or transferred through conventional futures or insurance instruments. Strategic risk is multidimensional while tactical risk has an identifiable one-to-one exposure such as price risk to futures contract (i.e. hedging). Therefore firms must manage strategic risk through proactive strategies.To illustrate; one of the strategic uncertainties agribusiness managers are facing because of the industrialization of agriculture is contractual or relationship risk. The expanding use of contractual agreements and other forms of negotiation-based linkages between the various stages contained in the agricultural production and distribution system, combined with the decline in market-based transactions, results in price risk being replaced by relationship or contractual risk for many businesses. A seed company may have a contract that guarantees access to enhanced genetic traits at a set price, but what happens if the biotech firm goes bankrupt or leaves the market? What happens to the status of the contract if the biotech firm finds other seed companies who can satisfy their need for market access at a lower price? This risk is not unlike that of losing a distributor or retailer in a particular area, but losing access to key suppliers is becoming a significant risk in the seed industry.

7.4.2 The Domain of Risk and Uncertainty

When viewed from the broader perspective of both strategic and tactical/operational risks, the total risk that agribusiness firms face is much more complex and more pervasive than is often perceived. In fact, as the agricultural sector increasingly exhibits the

characteristics of an industrial model, the types of risk it faces will change and so must the strategies that firms use to manage risks.

Table: Dimensions of Risk and Uncertainty in Agribusiness

Categories of Risk		Sources of Risk	
		Tactical Risk	**Strategic Risk**
Business /Operational	Operations and Business Practices	Natural hazards, facilities, disease outbreaks	Contractual risk, internal processes and controls, management transitions
	People and Human Resources	Health, contract terms, turnover	Recruiting, training, retention, organizational culture
	Strategic Positioning and Flexibility		Mergers and acquisitions, joint ventures, resource allocation and planning, organizational agility, information access
Financial	Financing and Financial Structure	Debt servicing, leverage, liquidity, solvency, profitability	Debt structure, non-equity financing,
	Financial Markets	Cash, interest rates, foreign exchange	Portfolio misalignment
Business Relationships	Business Partners and Partnerships	information asymmetries, adverse selection	Interdependency, confidentiality, cultural conflict, information sharing
	Distribution Systems and Channels	Cost, transportation, service availability, hold-up	Access, dependence on distributors
Market Conditions	Market Prices and Terms of Trade	Product price volatility, input price volatility	Contract terms, market outlets, market access
	Competitors and Competition	Market share, price wars	Antitrust, industrial espionage
	Customers and Customer Relationships	Product liability, credit risk, food recalls	Poor market timing, inadequate customer support
	Reputation and Image	Product recalls, defective products, rating agencies	Corporate image, brand image, reputation of key employees, community relationships
Policy and Regulation	Political	War, terrorism, civil unrest, law, governing agencies	Enforcement of intellectual property rights, change in leadership, revised economic policies, budget shortfalls
	Regulatory and Legislative	Reporting and compliance, environmental, food	Government trade negotiations, Government farm subsidies

		safety, traceability	
Technology	Technological	Asset specificity, research and development	Complexity, obsolescence, workforce skill-sets, adoption rate, diffusion rate

Check your Progress/ Self Assessment Questions
What is the reason for reduction of time lapse from trait identification to commercialization in corn genetics?

7.5 Decision theory

7.5.1 Decision-Making at the Farm Level

Decision-making at the farm level is basically the responsibility of the farmer or the enterprise manager. His task is likely to be easier and efficiency greater, if he has a simple and clear objective like, say, maximizing net financial return (or growth rate or whatever) and if he does not face any risk. It is likely to be somewhat more complicated if he has to modify such a straightforward maximization criterion by the need for minimizing the adverse effect of risks and uncertainties. If in addition he has to modify such a criterion by broader economic or social considerations, his decision-making process is likely to be much more complicated, being subject to diffusion (or confusion) of objectives and therefore inefficient. This difficulty can possibly be reduced if the farmer or the manager can follow a simple "maximization" criterion and decisions about broader economic and social criteria are taken at other, say, market or public authority levels and presented to him as given parameters, comprising a package of constraints and inducements. As a citizen he may seek to get these parameters modified but as an operator he has to consider them as given. Within these parameters, anything that may enable and encourage the farmer or the manager to be more knowledgeable, flexible, enterprising and innovative will make for better efficiency and economy in the short as well as the long run. Freedom to take decisions at the farm level and appropriate incentives for efficient management will help foster enterprise while provision of adequate research and information facilities will help promote innovation.

7.5.2 Private and Public Choice

But it is precisely in this context that decision-making for agriculture will start having its impact on decision-making "in" farms (or enterprises). Decision regarding the basic

parameters, e.g., the package of constraints and inducements, comprises the main substance of decision-making for agriculture. And this basically involves public choice as distinct from private choice. Generally speaking, if private choice is exercised at the operational level in the light of private costs and benefits and public choice at the regulatory level, keeping in view social costs and benefits, it should be operationally more efficient and economic. At least, it should be easier to apply the tests of efficiency and economy to the extent that the two can be viewed as two distinct processes. The relative importance of private and public choices, the levels at which they will be decided and the way they will interact with one another will, of course, vary widely between the market economy and socialist systems. But there will necessarily be a combination of the two in differing proportions under both the systems. For purpose of drawing inferences, however, there may be an advantage in considering them separately inasmuch as private choices will be based largely on economic reasoning while public choices will involve, in addition, a great deal of political reasoning. The nature of public choices will also differ significantly between market economy and socialist countries. Since decision-making in and for agriculture will involve different combinations of private and public choices under different situations, systems and time horizons, the subject is naturally of great interest to all agricultural economists. But while reasonable progress has been made in evolving analytical techniques for decision-making in agriculture, the concepts and tools available for decision-making for agriculture are yet most inadequate.

7.5.3 Decision-Making for Agriculture

As it was mentioned earlier, unlike decision-making at the farm level, which involves relatively straightforward criteria, decision-making for agriculture involves a variety of criteria, some relatively simple and others complex, some of immediate import and others of long term significance. In addition, there are policy decisions which are made with a focus on quite other matters (e.g., general economic policy measures) but have their effects on agriculture. Some of the less difficult, although quite important decisions for agriculture would be those relating to improvement of the information and security systems, which would help decision-making at the farm level in becoming more efficient.

Check your Progress/ Self Assessment Questions

Who is responsible for decision-making in the farm level?

7.6 Cobweb Theorem

The Cobweb Theorem attempts to explain the regularly recurring cycles in the output and prices of farm products. Frankly speaking, it is not a business cycle theory for it relates only to the farming sector of the economy. In 1930 Cobweb Theory was advanced by the three economists in Italy. Netherlands and the United States, apparently independently of each other almost at the same time. The names of Henery Schultz. (U.S.A.), Jam Tinbergen (Netherland) and Althus Hanau (Italy) are associated with' the theory, although the term Cobweb Theory was first suggested by Professor Nicholas Kaldor in 1934. It was so named because the pattern traced by the prices and output movements resembled a cobweb. The Cobweb Theory of trade cycle is based upon the foundation of 'lag' concept. It asserts that supply adjusts itself to changing conditions of demand which arc manifested through price changes not instantaneously but after certain period. This time, taken by the supply to adjust itself to changes in demand is known as lag. Thus the quantity supplied during any given time period is the function of the price prevailed in earlier time period to while the demand depends upon the price that prevails in period t itself. The core of this theory is that the response of supply to price ranges is not instantaneous.

The Cobweb Theory of trade cycle has its chief application in the case of agricultural products the supply of which can be increased or decreased with certain time-lag. Most crops can be sown and reaped only once a year. For instance, if the price of wheat increases say in September 2007 then supply will not increase instantaneously. The farmer will, of course, devote larger farm acreage to wheat cultivation in the next crop season and so it will take one year before supply increases in response to increase in wheat price. Thus the supply of wheat in 2008 will depend upon the price of wheat that prevailed in 2007 which offered the farmer inducement to devote more land to wheat cultivation.

7.6.1 Assumptions of Cobweb Theorem

This theorem is based on three assumptions:

A. Perfect competition in which each producer assumes that present prices will continue and that his own production plans will not affect the market,

B. Supply is a function of the previous period's price,

C. The commodity concerned is perishable.

These assumptions show that the theory is particularly applicable to agricultural products.

Since the supply in farming is slow to adjust itself to changes in demand and, violent fluctuations in prices and outputs are most likely to occur. For instance, an increase in demand will at once result in a spiral rise in price, since in the short period there can be no

increase in supply. This high price may make farmers increase their outputs to a greater degree than is justified by the increase in demand. Consequently when this increased supply comes to the market, there will be a sharp fall in price which may then result in a reduction in output in the next period to a greater extent again than is justified. The result is that violent changes in output succeed price longer in farm products. Professor Tinbergen has extended the application of Cobweb's analysis to durable goods the supply of which responds to demand changes after a significant time-lag because on account of long "gestation period", there is a considerable lag between the decision to produce and the actual deliveries of the durable goods.

7.6.2 Cobwebs have been divided into:

A. Continuous Cobwebs,

B. Divergent Cobwebs, and

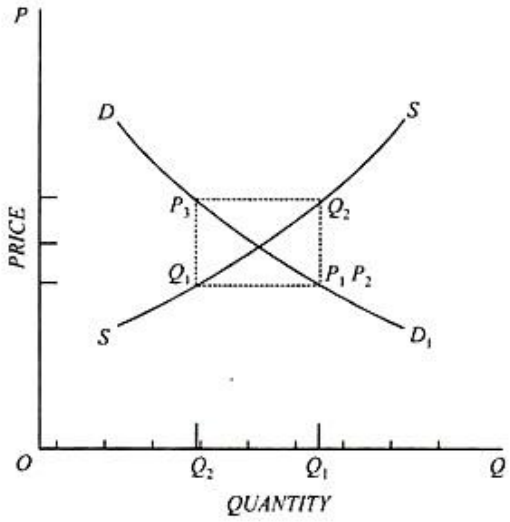
C. Convergent Cobwebs.

In the case of continuous Cobweb the fluctuations in price and output continues repeating about equilibrium at same level. In the case of diverging Cobweb the amplitude of the fluctuation increases with the passage of time. Once disturbed from position of equilibrium the economy moves cumulatively away from it into the doledrums of disequilibrium. This happens when the slope of the supply curve is less steep than the slops of demand curve. In the case of converging cobweb the economy, if and when disturbed from its equilibrium position, has a tendency to regain it through a series of oscillations. Each fluctuation is more damped than the one preceding it. This narrowing down of the amplitude of the fluctuations occurs when the slope of the supply curve is steeper than the slope of demand curve.

7.6.2.1 Case (I) Continuous Cobwebs:

Where the elasticity of supply is equal to the elasticity of demand the series of reactions works out as shown in the Figure below. The quantity in the initial, period (Q_1) is large, producing a relatively low price where it intersects the demand curve at P_7. This low price, intersecting the supply curve calls forth in the next period a relatively short supply Q_2. This short supply gives a high price, P_2 where it intersects the supply curve. This high price calls forth a corresponding increased production Q_3, in the third, with a corresponding low price, P_3. Since this low price in the third period is identical with that in the first, the production and price in the fourth, fifth, and subsequent periods will continue to rotate around

the path Q_2, P_2, Q_3, P_3 etc. As long as price is completely determined by the current supply, and supply is completely determined by the preceding price, fluctuation in price and production will continue in this unchanging pattern indefinitely, without an equilibrium being approached or reached. This is true in this particular case because, the demand curve is the exact reverse of the supply curve so that at their overlap each has the same elasticity. This case has been designated the "case of continuous fluctuations."

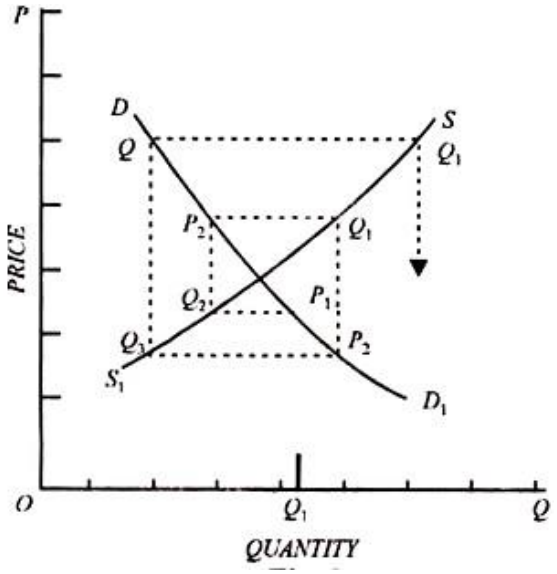


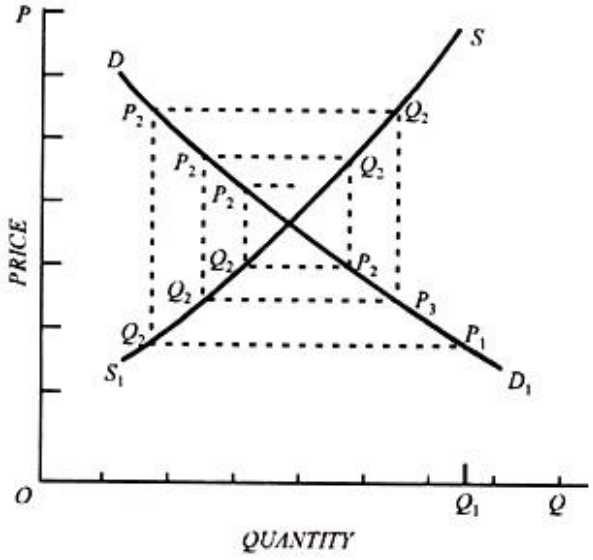
7.6.2.2 Case (2) Divergent Cobweb:

Where the elasticity of supply is greater than the elasticity of demand, the series of reactions works out as shown in Figure below. Starting with the moderately large supply, Q_1 and the corresponding price P_1, the series of reactions is traced by the dotted line. In the second period, there is a moderately reduced supply, Q_2, with the corresponding higher price, P_2 . This high price calls forth a considerable increase in supply, Q_3 in the third period, with a resulting material reduction in price, to P_3. This is followed by a sharp reduction in quantity produced in the next period to Q_4, with a corresponding very high price, P_4. This fifth period sees a still greater expansion in supply to Q_5 etc. Under these conditions the situation might continue to grow more and more unstable, until price fell to absolute zero, or production was completely abandoned, or a limit was reached to available resources (where the elasticity of supply would change) so that production could no longer expand. The case has been designated the "case of divergent fluctuation."

7.6.2.3 Case (3) Convergent Cobweb:

The reverse situation, with supply less elastic than demand, is shown in Fig. 3. Starting with a large supply and low price in the first period, P_1there would be a very short supply and high price, Q_2, and P_2, in the second period. Production would expand again in the third period to Q_3 but to a smaller production than that in the first period. This would set a moderately low price, P_3, in the third period, with a moderate reduction to Q_4 in the fourth period; and a moderately high price P_4. Continuing through Q_9, P_6 and Q_6, and P_6, production and price approach more and more closely to the equilibrium condition where further changes would occur. Of the three case considered thus so far, only this one behaves in the manner assumed by equilibrium theory; and even it converges rapidly. If the supply curve is markedly less elastic than the demand curve. The case has been designated "the case of convergent fluctuation.





The Cobweb theory of trade cycle represents an important forward step in the development of the dynamic explanations of the cyclical fluctuations. The earlier approaches to the study of the cycle problem were static in character. They treated the economy as of a point in

time ignoring completely the movements of the economy through time. To the extent the adjustments between supply and demand were assumed to take place instantaneously and not with a certain degree of time lag, the earlier approaches were static and could not furnish useful tools that could be applied with a fair degree of reliance for solving the problem of economic fluctuations in the dynamic economy where adjustments involved lags. The Cobweb Theorem furnishes us with an illustration of the dynamic process of adjustment movements through time.

7.6.3 Criticism of Cobweb Theory:

Like all other theories of trade cycle, the Cobweb Theory too suffers from some severe limitations:

A. This is not strictly a trade cycle theorem for it is concerned only with the farming sector. There are a good many others sphere of production where it says nothing.

B. This theorem assumes that the output is solely governed by price. Thus is unrealistic assumption. The fact is that the output particularly of farm products is determined not only by price, but by several other factors—weather, prices of the factors of production.

C. It is applicable only where:

(a) The price is governed by the supply available,

(b) When production is governed only by the considerations of price as wider perfect competition, and

(c) When production cannot vary before the expiry of one full period.

D. The theory is based upon the unsound assumption that the crop which farmer plants in 2008 depends solely on the prices ruling in 2007. As a matter of fact this is contrary to facts. When 2007 prices undoubtedly influence decisions regarding 2008 crops, producers are also influenced by their expectations.

Producer's decisions with regard production during any given period depend not only upon the backward look but also on the forward guess. If this year's price is high, producers are apt to foresee some reaction to the high price and anticipate larger output by their competitors next year.

E. This theory of trade cycle suffers from another weakness too. If we look at the Fig showing the diverging cobweb cycle, we find that disequilibrium once began continues indefinitely. The curves show that once the equilibrium is upset, the system falls into a series of unending cycles. In practice, however, this is most unlikely to happen. Commonsense tells that it cannot happen. In practice the shape of the curves is such as to make continued divergence impossible.

F. It can also be argued that even the constant type of cobweb cycle would not continue indefinitely.

Bankruptcy would ultimately put an end to a cycle of this type. Thus it is in a way correct to assert that in so far as the cycles of the cobweb occur in practice they are either converging cycles that tend towards a new equilibrium position on temporary affairs limited by the ultimate-bankruptcy of people in industry and business.

7.6.4 Conclusion to Cobweb Theory:

We conclude that in spite of its shortcomings the Cobweb Theory is important besides its application as an explanation for the cyclical behaviour of wheat and other agricultural products' markets. It concentrates attention on the important fact that the present events depend upon the past happenings It furnishes us with a technique to demonstrate the process of change over time.

Check your Progress/ Self Assessment Questions

What's the Cobweb theorem attempted to explain?

What the assumptions of Cobweb theorem generally show?

What ate the various types of cobweb discussed in the theorem?

7.7 Nerlove's Model

The Nerlove's model of agricultural supply response is one of the most successful in applied econometrics, as evidenced by the hundreds of subsequent studies that use it productively. A nagging and recurring problem, however, concerns the variability of estimated supply response.

The standard structural form of the Nerlove's model is:

$$A_t^* = \alpha_0 + \alpha P_t^e + u_t \quad (1)$$

$$P_t^e = P_{t-1}^e + \gamma (P_{t-1} - P_{t-1}^e) \quad (2)$$

$$A_t = A_{t-1} + \theta (A_t^* - A_{t-1}) \quad (3)$$

$$u_t \overset{iid}{\sim} (0, \sigma_u^2), \quad (4)$$

Where A denotes crop acreage under cultivation, P is crop price, A^* is desired acreage, P^e is expected future price, and α_0, α, Υ, θ and σ_u^2 are parameters.

Equation (1) describes the relationship between desired acreage and expected price. Economic theory predicts that $\alpha \geq 0$, and there are economic reasons to expect $\alpha_0 > 0$ as 0

well, due to subsistence farming. Equations (2) and (3) represent a simple adaptive expectations partial-adjustment mechanism linking P^e and A^* to observable P and A values. The adjustment parameters Υ and θ are expected to be positive.

The reduced-form equation relating acreage and price is found by solving equations (1) - (4) for acreage in terms of the observable variables of the system, yielding

$$A_t = b_1 + b_2 P_{t-1} + b_3 A_{t-1} + b_4 A_{t-2} + e_t, \qquad (5)$$

Where

$$b_1 = \alpha_0 \gamma \theta$$

$$b_2 = \alpha \gamma \theta$$

$$b_3 = (1 - \gamma) + (1 - \theta)$$

$$b_4 = -(1 - \gamma)(1 - \theta)$$

$$e_t = \theta u_t - [\theta(1-\gamma)]u_{t-1}.$$

The parameter of interest, α, is expressed in terms of the reduced-form parameters as

$$\alpha = \frac{\delta_1}{\delta_2}, \qquad (6)$$

Where

$$\delta_1 \equiv b_2$$

$$\delta_2 \equiv (1 - b_3 - b_4).$$

In practice, of course, the reduced form must be estimated. Least squares (LS) may not be strictly appropriate, however, because the reduced-form disturbance is potentially serially correlated and the regress or include lagged dependent variables. We nevertheless focus on LS estimation and an improvement obtained via Bayesian shrinkage techniques. Our focus is entirely appropriate in certain cases. If, for example, expectations adapt quickly (that is, if Υ is close to 1), then the reduced-form disturbance is approximately white noise. Alternatively, if the supply-response equation's disturbance is serially correlated, and if that serial correlation is approximately first-order autoregressive with parameter 1-Υ, then the reduced-form disturbance is again approximately white noise. Much more important than any such special cases, however, is the recognition that regardless of whether LS is entirely appropriate, it has nevertheless been used regularly in the applied agricultural economics literature. Because we want to mimic what's done in practice, our research strategy is to

follow suit, and to ask whether improvements are nevertheless possible within the LS framework via Bayesian shrinkage techniques. As we shall show, our strategy yields important insights, even if it leaves certain other issues unaddressed. Let "^" denote the LS estimator of the reduced-form parameter vector. The estimate of α is formed as

$$\hat{\alpha} = \frac{\hat{\delta}_1}{\hat{\delta}_2} = \frac{\hat{b}_2}{(1 - \hat{b}_3 - \hat{b}_4)} . \qquad (7)$$

Note in particular that $\hat{\alpha}$ is formed as the ratio of two random variables $\hat{\delta}_1$ and $\hat{\delta}_2$. Under very general conditions, ratios or reciprocals of random variables have Cauchy tails and hence no finite moments. Moreover, as shown by Zellner for the normal case and Lehmann and Popper Shaffer or more general cases, the distributions of reciprocals or ratios will, in general, be multimodal (typically bimodal). Both the non-existence of moments and the multimodality may contribute to high variability in estimates of agricultural supply response.

Check your Progress/ Self Assessment Questions

Nerlove's model basically deals with _____.

7.8 Agricultural Marketing

Agricultural marketing system is an efficient way by which the farmers can dispose their surplus produce at a fair and reasonable price. Improvement in the condition of farmers and their agriculture depends to a large extent on the elaborate arrangements of agricultural marketing. The term agricultural marketing include all those activities which are mostly related to the procurement, grading, storing, transporting and selling of the agricultural produce. Thus Prof. Faruque has rightly observed: "Agricultural marketing comprises all operations involved in the movement of farm produce from the producer to the ultimate consumer. Thus, agricultural marketing includes the operations like collecting, grading, processing, preserving, transportation and financing."

7.8.1 Present State of Agricultural Marketing in India

In India four different systems of agricultural marketing are prevalent:

Sale in Villages: The first method open to the farmers in India is to sell away their surplus produce to the village moneylenders and traders at a very low price. The moneylender and traders may buy independently or work as an agent of a bigger merchant of the nearly mandi.

In India more than 50 per cent of the agricultural produce is sold in these village markets in the absence of organized markets.

Sale in Markets: The second method of disposing surplus of the Indian farmers is to sell their produce in the weekly village markets popularly known as 'hat' or in annual fairs.

Sale in Mandis: The third form of agricultural marketing in India is to sell the surplus produce though mandis located in various small and large towns. There are nearly 1700 mandis which are spread all over the country. As these mandis are located in a distant place, thus the farmers will have to carry their produce to the mandi and sell those produce to the wholesalers with the help of brokers or 'dalals'. These wholesalers of mahajans again sell those farm produce to the mills and factories and to the retailers who in turn sell these goods to the consumers directly in the retail markets.

Co-operative Marketing: The fourth form of marketing is the co-operative marketing where marketing societies are formed by farmers to sell the output collectively to take the advantage of collective bargaining for obtaining a better price.

7.8.2 Defects of Agricultural Marketing in India

Following are some of the main defects of the agricultural marketing in India:

Lack of Storage Facility: There is no proper storage or warehousing facilities for farmers in the villages where they can store their agriculture produce. Every year 15 to 30 per cent of the agricultural produce is damaged either by rats or rains due to the absence of proper storage facilities. Thus, the farmers are forced to sell their surplus produce just after harvests at a very low and un-remunerative price.

Distress Sale: Most of the Indian farmers are very poor and thus have no capacity to wait for better price of his produce in the absence of proper credit facilities. Farmers often have to go for even distress sale of their output to the village moneylenders-cum-traders at a very poor price.

Lack of Transportation: In the absence of proper road transportation facilities in the rural areas, Indian farmers cannot reach nearby mandis to sell their produce at a fair price. Thus, they prefer to sell their produce at the village markets itself.

Unfavorable Mandis: The conditions of the mandis are also not at all favorable to the farmers. In the mandis, the farmers have to wait for disposing their produce for which there is no storage facilities. Thus, the farmers will have to lake help of the middleman or dalal who lake away a major share of the profit, and finalizes the deal either in his favour or in favour of arhatiya or wholesalers. A study made by D.S. Sidhu revealed that the share of middlemen in

case of rice was 31 per cent, in case of vegetable was 29.5 per cent and in case of fruits was 46.5 per cent.

Intermediaries: A large number of intermediaries exist between the cultivator and the consumer. All these middlemen and dalals claim a good amount of margin and thus reduce the returns of the cultivators.

Unregulated Market's: There are huge numbers of unregulated markets which adopt various malpractices. Prevalence of false weights and measures and lack of grading and standardization of products in village markets in India are always going against the interest of ignorant, small and poor farmers.

Lack of Market Intelligence: There is absence of market intelligence or information system in India. Indian farmers are not aware of the ruling prices of their produce prevailing in big markets. Thus, they have to accept any un-remunerative price for their produce as offered by traders or middlemen.

Lack of Organization: There is lack of collective organization on the part of Indian farmers. A very small amount of marketable surplus is being brought to the markets by a huge number of small farmers leading to a high transportation cost. Accordingly, the Royal Commission on Agriculture has rightly observed, "So long as the farmer does not learn the system of marketing himself or in cooperation with others, he can never bargain better with the buyers of his produce who are very shrewd and well informed."

Lack of Grading: Indian farmers do not give importance to grading of their produce. They hesitate to separate the qualitatively good crops from bad crops. Therefore, they fail to fetch a good price of their quality product.

Lack of Institutional Finance: In the absence of adequate institutional finance, Indian farmers have to come under the clutches of traders and moneylenders for taking loan. After harvest they have to sell their produce to those moneylenders at unfavorable terms.

Unfavorable Conditions: Farmers are marketing their product under advice circumstances. A huge number of small and marginal farmers are forced by the rich farmers, traders and moneylenders to fall into their trap to go for distress sale of their produce by involving them into a vicious circle of indebtedness. All these worsen the income distribution pattern of the village economy of the country.

7.8.3 Remedial Measures for Improvement of Agricultural Marketing

Improvement of the agricultural marketing in India is utmost need of the hour.

The following are some of the measures to be followed for improving the existing system of agricultural marketing in the country:

i) Establishment of regulated markets.
ii) Establishment of co-operative marketing societies.
iii) Extension and construction of additional storage and warehousing facilities for agricultural produce of the farmers.
iv) Expansion of market yards and other allied facilities for the new and existing markets.
v) Provision is made for extending adequate amount of credit facilities to the farmers.
vi) Timely supply of marketing information's to the farmers.
vii) Improvement and extension of road and transportation facilities for connecting the villages with mandis.
viii) Provision for standardization and grading of the produce for ensuring good quality to the consumers and better prices for the farmers.
ix) Formulating suitable agricultural price policy by the Government for making a provision for remunerative prices of agricultural produce of the country

Check your Progress/ Self Assessment Questions

What is agricultural marketing system?

What are the different systems of agricultural marketing prevailing in India?

7.9 Marketed and Marketable Surplus

Marketable Surplus is a theoretical ex ante concept which represents the surplus which the farmer/producer has available with himself for disposal once the genuine requirements of the farmer's family consumption, payment of wages in kind, feed, seed and wastage have been met. Marketed Surplus as compared to Marketable Surplus is a practical ex-post concept and refers to that part of the marketable surplus which is marketed by the producer i.e., not only the part which is available for disposal but that part which is made available to the market or to the disposal of the non-farm rural and urban population. The farmer, in case of commercial agriculture is motivated by profit considerations, so he takes his whole produce to the market and purchases his requirement from the market, but in the case of subsistence agriculture the concept of marketed and marketable surplus becomes relevant as the farmer generally produces for his own subsistence and it is only the remainder left after meeting his own requirements, that is taken to the market for sale. The concept of "Marketable Surplus" is subjective because the feature of retention of the farmer is a matter of subjective guess. The concept of "Marketed Surplus", on the other hand, is objective,

because it refers specifically to the marketed amount i.e., to the actual quantity which enters the market. In most cases the marketed part may be more than the theoretically marketable part because out of the marketable part the farmer may be willing to sell only a part. He may hoard part of it in anticipation of rising price of the grain or for some other reasons. In certain cases, marketed surplus may be greater than the marketable surplus. This happens when the farmers are driven to distress sales. There may be in the case of a subsistence farmer who has produced just to meet his family consumption requirements. But he may take some portion of his produce to the market to meet his immediate cash obligations. In such cases, the marketed surplus released by the farmer will not be the real one also the portion marketed will be greater than what he considers marketable because of distress sales.

7.9.1 Computation of Marketable Surplus

It is computed by the formula MS = A – B

Where MS is Marketable Surplus,

A - stands for net availability of the given crop in the year of reference and

B - stands for the following items in the same year:

(i) Consumption by the farm family,

(ii) Consumption by permanent labour engaged on the farm,

(iii) Consumption by the temporary labour occasionally employed on the farm,

(iv) Quantity retained for seed,

(v) Quantity retained as feed for farm animals,

(vi) Quantity retained for barter,

(vii) Payments in kind: a. to permanent labour, b. to temporary labour, c. for machinery and equipment, d. for customary payments, e. to land owners as rent, f. to land owners as share of produce, g. for re-payment of loan, h. land revenue, i. irrigation charges, and j. others.

(viii) Physical losses: a. in threshing and winnowing, b. in transport from threshing floor to storage, and c. in storage at producer’s level.

7.9.2 Computation of Marketed Surplus

In case the quantity actually retained for consumption (and not the quantity actually required for consumption) is taken into account, the quantity calculated is the marketed surplus i.e., the quantity sold will include the distress sales.

The marketed surplus will thus be according to the formula: MS = A – B

Where, A stands for production and

B includes all the items mentioned above apart from viii) (c) i.e., viii) Physical losses: c) In storage at producer's level. The term "Consumption by the farm family" of the cultivator households refers to the quantity actually retained for consumption by the family irrespective of the actual total requirements for the purpose.

For Accounting Purpose we have, Marketable Surplus=Net availability of the Crop in the year – Retention including all seed, feed and wastage – Subtracting Purchases, Distress Sales and Repurchases therein.

Marketed Surplus=Net availability of the Crop in the year – Retention included seed, feed and wastage losses apart from losses at producer level – Purchases + Distress Sales (i.e., Distress Sales are included in marketed surplus also Repurchases occurring after distress sales are not subtracted from Net Availability)

Check your Progress/ Self Assessment Questions

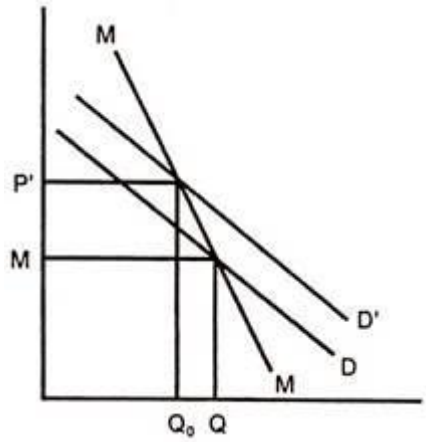
Marketable Surplus is a theoretical _____ concept.

Marketed Surplus is a practical _____ concept.

7.10 Mathur-Eizkel Hypothesis

P.N. Mathur and H. Ezekiel in a very controversial paper hypothesized that "marketable surpluses are inversely related to prices." In other words, if the prices rise, marketable surpluses will become lower and when the price are low marketable surpluses will be higher. It means price rise does not act as a stimuli but a damper. On the face of it this thesis will appear contrary to the expected behaviour of any producer. Many economists considered it not only to be incorrect but outrageous. However, Mathur and Ezekiel had certain explanations. They were of the opinion that the cash requirements for non-food items are fixed! The farmers have a sort of static way of living for which the cash requirements are fixed. This is another way of saying that the farmers are the persons with fixed aspirations. They have a fixed labour preference and if lower level of labour brings the same income, they

will increase their leisure preference. As prices rise, a lower output secures for them the desired income in money terms. They, therefore, reduce labour and have greater leisure and thus produce less!



Like any other demand curve, here also the demand curve has a negative slope; meaning thereby that at higher prices the demand will be low and vice versa. 'M' curve is the curve for marketable surplus. It also has a negative slope. It shows that with a fall in price, marketable surplus will increase or will have to be increased so that a particular amount of money can be obtained. As the demand rises to D′, price rises to P′. At higher price the marketable surplus is reduced from Q to Q_0. (It is to be noted here that the diagram does illustrate that with rise in demand and hence with rise in price, the marketable surplus will decline. However, this 'proof is based on the hypothesis of negatively sloping 'marketable surplus supply curve'. If this assumption is arbitrary or incorrect, then the proof becomes dubious ipso factor.) Mathur and Ezekiel had in mind the picture of a typical rural society. In this society, the farmers consume bare minimum. They have capacity to reduce their consumption or increase the same. They believed that the consumption of food grains by the farmers is 'residual'. It will go down in lean income years and go up in bumper income years. In other words, as there is bumper income, first the consumption goes up and then the marketable surplus will be decided. Since the cash requirements of the farmers for non-food needs are fixed, it will not be the marketable surplus or marketed surplus that will be increased in times of bumper income but the consumption. In their model there seems to be infinite possibility of increasing consumption. The consumption-production relationship is very high. Mathur and Ezekiel model is a short-run model. It is in the short run that the cash requirement for non-food items is fixed. Hence, this inverse relationship Mathur and Ezekeil believe that the

demand for cash is inelastic, i.e., cash requirements are fixed. It is clear that Mathur and Ezekiel could have formulated their hypothesis or thesis on the basis of certain hunches only. They probably based their observations on deductive logic about macro behaviour. In order to 'prove' their hypothesis they took shelter behind the short-run behaviour. Mathur and Ezekiel had taken that picture of cultivation in which the government dues from the farmers were related to the size of the land, rather than output. Since the acreage remains the same, land revenue obligation was presumed to be static. Short-term investment requirements also remain the same. Mathur and Ezekiel hypothesized that the subsistence farmers will increase their consumption since they were consuming far below the satisfactory level. However, why should super-marginal farmers not provide greater marketable surplus as production goes up? They cannot consume more because they must already be consuming as much as they could. The reason that is advanced by Mathur and Ezekiel is that these farmers build up inventories in kind. Agriculture depends upon the vagaries of rain pattern and who knows the next crop may fail or fail partially. Stocks have got to be built up both for consumption and seeds. They are built up in kind. Thus, super-marginal farmer save-not in the form of cash but in kind. Hence, marketable surpluses (marketed surpluses) do not go up. Dharam Narain later 'confirmed' the Mathur and Ezekiel thesis with the help of some empirical evidence that he collected from the data relating to the year 1950-57. He was of the opinion that as the size of holding increases up to 15 acres, the marketable surplus decreases; the reason being the same, i.e., more is required for consumption purposes. Farmers having smaller land must be having consumption gap. Since most of the marketable surplus (almost 50%) came from the farmers owning less than 10 acres of land, the overall effect of Mathur and Ezekiel is realised. When we give high weightage to the marketable/marketed surplus of the small farmers (near subsistence level farmers), the Mathur and Ezekiel effect will be found to be realistic. Marketable surplus was shown to be result of tension between (i) price elasticity of demand for foodgrains, and (ii) income elasticity of demand for food grains.

7.10.1 Two conclusions are appended

A. If the price elasticity of demand is greater than the income elasticity, then the marketable surplus curve will have a positive slope (not the Mathur and Ezekiel type).

B. If, however, the income elasticity exceeds the price elasticity, the marketable surplus will have a negative slope.

[In the second case when the prices raise the income effect outweighs the substitution effect and, therefore, consumption rises].

Income elasticity of demand will naturally be high at low levels of income. In this case as the prices rise, income will rise. Rise in income will increase the demand for food for consumption purposes and hence the marketable surplus will decline.

7.10.2 Critical Evaluation of Mathur-Ezekiel Thesis

Mathur and Ezekiel thesis is contradicted by micro evidence. Time has made it hopelessly incorrect. During the last three decades, even in a country like India, the farmers have become quite materialistic. Their cash requirements for non-food items are not static what to say in the short period, but even on day-to-day basis. With so many consumption goods in the market, the farmers covet the industrial goods as much as others. Hence, the cash requirements are always rising.

Secondly, India has become self-sufficient in food grains long back and income elasticity of demand for food grains is showing downward tendency. Of course there are people 'below the poverty line' but, by and large, they too are not starving.

The price of inputs of agriculture is rising. With that is rising the cash requirement of the farmers. This cash requirement can be met only by disposing of marketable surpluses. So far as dues of government revenue are concerned, either the land revenue has been abolished on small farms in most of the India states or it has been made more elastic to farm income rather to farm size. Though agricultural income is not taxed, agricultural inputs have tax elements in them. (Not all inputs are provided with the subsidies).

Hence, cash requirements for all these purposes are also not fixed.

It is true that a prudent farmer will save in kind for insuring his family against starvation if the next crop fails. He would also like to save the seeds in kind rather than in cash-equivalent. However, this is true in case of rudimentary economy. When organizations like Food Corporation of India or state/central warehousing corporations exist, and when there is surpluses food over the above the consumption requirements, the farmers do not retain the tendency to hoard. In fact fearing storage losses at home on fall in price in the next bumper season, they can dispose of all surpluses, albeit in a phased manner so that terms of trade do not deteriorate.

Mathur and Ezekiel hypothesis is a pure static case. When agricultural income grows as a result of increase in production and/or rise in prices, the elasticity of the marketable surplus will invariably positive. Expectations about the future price behaviour were neglected

in Mathur and Ezekiel thesis. If prices are expected to rise, the marketable surplus will be higher than the marketed surplus, but if prices are expected to fall, then the marketed surplus will be equal to marketable surplus.

In practice, the elasticity of supply of agricultural output is within a wider range than the elasticity of demand. If the elasticity of the marketable surplus (also known as the elasticity of supply or elasticity of offer curve) is greater than the elasticity of demand curve, then the price movements will be explosive.

If the elasticity of demand fluctuates within a narrow limit (as it does) as also the elasticity of offer curves, then there will be possibility of equilibrium and price fluctuates will be narrow. Since usually it is the first case, the price fluctuations are erratic. In such a case, the fluidity of Mathur and Ezekiel thesis cannot sustain.

Then gone are the days of rent being collected in kind, i.e., in the form of a part of the crop. This was true in the days of zamindars and heartless landlords. In those days in the year of bad harvest the surplus left over rent declined. After the consumption reserves, the marketable surpluses used to be low. Thus, in a period of bad harvest when prices used to go up, the marketable surpluses used to be low. Now this entire economics has become irrelevant (except where landlordism of the old times prevails).

Prof. Raj Krishna had conducted a study back in 1961 and came to this conclusion-

No general presumption in favour of the irresponsiveness of crop output to prices in poor economics can be upheld. The responsiveness, however, varies as between different crops and regions.

The elasticity of the marketable surplus is never negative so long as the substitution effect is non-zero.

A series of studies have been made about the phasing of the marketable surpluses into the marketed surpluses. Studies abounded between the time period 1951 and as late as (say) 1985.

7.10.3 The following conclusions emerge

(a) With economic development, government support and betterment of even small farmers, the ‘distress’ sales might have gone down, but post-harvest bulk sales continue. Thus while we may not use the words ‘distress sales’ for the immediate post-harvest sales, the fact remains that 50 to 75 per cent marketable surplus is unloaded in the market immediately in the first quarter after the harvest.

It is a different matter that these sales are not made to the 'greedy traders', 'loan sharks', or 'money-lender-cum- landlords'. Rich or well-to-do consumers also make purchases for the entire year and then there are organisations like government purchase agencies, including the Food Corporation of India.

(b) Farmers do not phase out their marketable surpluses during the lean period but the bulk-buying agencies do. Rich farmers may do so but the age-old pattern of bulk sales within six months of the post-harvest season remains.

This saves the farmers from the storage costs and risks. The farmers are becoming banking minded. They sell their marketable surpluses and convert them in cash. Premium is not earned in the form of higher prices of marketable surpluses but in the form of interest. This is not to say that everybody does that but only to say that now there are three ways in which these surpluses can be held- (i) stocks for future consumption, (ii) stocks for future sale and/or seed-stocks, and (iii) conversion in the form of cash.

Thus, it can be concluded that the Mathur and Ezekiel hypothesis is a very static case even for short period. It has some relevance for rudimentary agricultural economy but not for others. When agricultural production increases, the elasticity of the marketable surplus will invariably be positive.

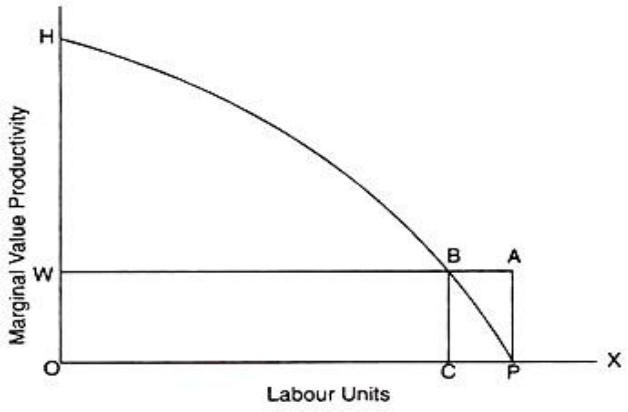
Check your Progress/ Self Assessment Questions

What is the relation between marketable surpluses prices in the Mathur-Eizkel hypothesis?

7.11 Farm Size and Productivity

The Farm Management Studies conducted by the Ministry of Food and Agriculture in certain selected regions of India in the mid-1950s clearly revealed that output per acre declined with the increase in the size of holding. Several explanations have been offered for this inverse relationship between farm size and output per acre.

The most important explanation advanced in this regard, is in terms of the low opportunity cost of family labour and the resultant variations in the amount of labour input used on different size classes of farms. It is based on the argument that the smaller farms, characterized by peasant family cultivation, extend the input of labour right up to the point where the marginal product of labour is zero (i.e., point P in the figure given below) or at least much below the ruling market wage rate. On the larger farms, the use of hired labour stops at the level (OC in the diagram) where its marginal product equals the market wage. Hence the smaller farms have higher.



The inverse relationship between farm size and productivity was claimed by many to be a confirmed phenomenon in traditional agriculture during 1950's. Under the impact of the new technology which is essentially capital-based (compared with the labour based technology of the traditional agriculture), the productivity advantage hitherto enjoyed by the small farmers with relative abundance of family labour started moving in favour of the large farms which have relative abundance of land also a more easy access to capital. There is strong evidence that after green revolution in India, the inverse relationship started yielding place to at least a 'constant' relationship if not a positive relationship between farm size and productivity.

Hanumantha Rao for example reached such a conclusion in 1975. He showed the weakening and even disappearance of the inverse relationship between farm size and output per acre by comparing the relationship under traditional technology during the fifties with that under new technology in the late sixties in some districts of U.P., Punjab and Andhra Pradesh. Studies by Bhattacharya and Saini, Chadha and by Kapur and Kahlon, based on the data collected in the post green revolution era also showed that the inverse relationship was disappearing.

Sen and Rudra also reviewed this controversy in 1980 and they found that the inverse relationship got weakened or even disappeared in areas using new technology. Their conclusion was, **"The negative relation may hold in certain parts of the country at certain time but not everywhere and not yet all times."**

They also felt that even were the inverse relationship between size of the farm and the productivity was found to exist, it existed only in certain ranges. According to them, no conclusion that was based upon the data for one region should be considered as valid for the whole of the country. Madhusudan Ghosh has also confirmed that the inverse size-productivity relation is found to be reversed in areas undergoing technological change.

Similarly it was found that in the region with traditional agriculture, the amount spent per acre on the modern inputs was smaller on large farms than on small farms.

Check your Progress/ Self Assessment Questions

Several explanations have been offered for _____ relationship between farm size and output per acre.

The negative relation may hold in _____ of the country at _____ but not everywhere and not yet all times.

7.12 Pricing policy (including support price)

The initial price policy at the dawn of Independence was, to a large extent, based on the plethora of controls exercised during the Second World War. It included rigid controls on movement of crops from one State to the other, procurement of food grains through a compulsory levy on producers and millers, open market purchases, and rationing in practically all the States. Following the recommendation of the Food grains Policy Committee of 1947 for progressive decontrol, restrictions were relaxed. However, a food crisis appeared in 1948 and food prices rose substantially. Accordingly, controls were introduced.

On the recommendations of the Food grains Enquiry Committee, 1957, calling for 'social control over the wholesale trade in food grains' and its subsequent endorsement by the National Development Council in November 1958, the Government of India experimented with State trading in food grains in April 1959. According to this scheme, state trading was to be confined to two main commodities - wheat and rice. However, the scheme ran into difficulties since it was put into practice in a haphazard way without taking cognizance of economic forces.' For instance, procurement prices for wheat were fixed at much lower levels than those dictated by the forces of demand and supply.

The government formulated price policy for agricultural produce to secure remunerative prices for farmers to encourage them to invest more in agricultural production. Keeping in mind, the government announces Minimum Support Prices (MSP) for major agricultural products every year. Government provides food grains to the BPL families through the public distribution system. These prices are fixed after consulting the Commission for Agricultural Costs and Prices (CACP).

The Commission of Agricultural Costs and Prices (CACP) while recommending prices takes into account important factors, such as:

I. Cost of production, II. Changes in input prices, III. Input/output Price Parity, IV. Trends in market prices, V. Inter-crop Price Parity, VI. Demand and supply situation, VII. Effect on Industrial Cost Structure, VIII. Effect on general price level, IX. Effect on cost of living, X. International market price situation, XI. Parity between prices paid and prices received by farmers (Terms of Trade)

7.12.1 Motives (advantages) behind the announcement of Minimum Support Price (MSP):

To secure the interests of the farmers as also the need of self reliance, government has been announcing the minimum support price for 24 major crops. The main objectives f the MSP are:

I. To prevent fall in the price in the situation of over production.

II. To protect the interests of the farmers by ensuring them a minimum price for their crops in the situation of a price fall in the market.

III. To meet the domestic consumption requirement

IV. To provide price stability in the agricultural product

V. To ensure reasonable relationship between prices of agricultural commodities and manufactured goods

VI. To remove price difference between two regions or the whole country.

VII. To increase the production and exports of agricultural produce.

VIII. To provide raw material to the different industries at reasonable prices in the whole country.

7.12.2 Disadvantages of the Minimum Support Price:

I. To increase the income of the farmers, the poor of the country have to pay more. This practice will create the problem to allocate inefficiency in the country.

II. Subsidizing farmers through higher product prices is an inefficient method because it penalizes the consumer with higher prices. Also it means large farmers will benefit the most. They have received more than they need but small farmers are still struggling.

III. Farmers use fertilizers in the huge quantity to increase their production but it creates problems for those peoples who do not get benefits from this increment in the production.

7.12.3 Conclusion

The basic motive behind the Agriculture policy of Government of India is to save the interests of both farmers and consumers. The prices of the food grains should be decided very wisely so that neither farmers nor consumers get suffer.

Check your Progress/ Self Assessment Questions

The initial price policy at the dawn of Independence was based on?

How many crops were included in MSP?

7.13 Let us sum up

In this unit we have understand the Cobb-Douglas production function with its criticisms and importance followed by Spillmans production function. Then we have analyzed the risk and uncertainty in agricultural production and prices with special reference to strategic and tactical risk with uncertainty and the domain of risk and uncertainty. Then we get an idea regarding decision-making at the farm level along with decision-making for agriculture. Then we have discussed about Cobweb Theorem and Nerlove's Model. Then we get idea regarding agricultural marketing with the present state of agricultural marketing in India along with its defects also with remedial measures for its improvement. We get the idea regarding marketed and marketable surplus with its computations. The unit also gives us idea regarding Mathur-Eizkel Hypothesis with its critical evaluation. The unit finally concluded with farm size and productivity relationship followed by pricing policy including support price.

7.14 Key Terms

Agricultural Marketing System: It is an efficient way by which the farmers can dispose their surplus produce at a fair and reasonable price. Improvement in the condition of farmers and their agriculture depends to a large extent on the elaborate arrangements of agricultural marketing.

Marketable Surplus: It is a theoretical ex ante concept which represents the surplus which the farmer/producer has available with himself for disposal once the genuine requirements of the farmer’s family consumption, payment of wages in kind, feed, seed and wastage have been met. **Marketed Surplus**; As compared to Marketable Surplus is a practical ex-post concept and refers to that part of the marketable surplus which is marketed by the producer i.e., not only the part which is available for disposal but that part which is made available to the market or to the disposal of the non-farm rural and urban population.

7.15 Answer to 'Check Your Progress'

Q. What is the nature of Cobb-Douglas production function?

A. Cobb-Douglas production function is a linear homogeneous production function.

Q. Express the CD production function

A. The CD function can be expressed as $Q = AL^{\alpha}K^{\beta}$, Where, Q = output, A = positive constant, K = capital employed, L = Labor employed, α and β = positive fractions shows the elasticity coefficients of outputs for inputs labor and capital, respectively.

Q. How the homogeneity of the CD production function can be checked?

A. The homogeneity of the Cobb-Douglas production function can be checked by adding the values of α and β.

Q. What is the nature of Spillman production function?

A. Spillman production function is an exponential-type function.

Q. When Spillman production function remain locally regular?

A. It remain locally regular when $\beta_1 > 0$, $0 < \beta_2 < 1$, $0 < \beta_3 < 1$, $0 < \beta_4 < 1$ and $0 < \beta_5 < 7$.

Q. What is the reason for reduction of time lapse from trait identification to commercialization in corn genetics?

A. biotechnology and genetic engineering is the reason of reduction time lapse from trait identification to commercialization in corn genetics.

Q. Who is responsible for decision-making in the farm level?

A. Farmer or the enterprise manager is responsible for decision-making at the farm level.

Q. What's the Cobweb theorem attempted to explain?

A. Cobweb Theorem attempts to explain the regularly recurring cycles in the output and prices of farm products.

Q. What the assumptions of Cobweb theorem generally show?

A. The assumptions show that the theory is particularly applicable to agricultural products.

Q. What ate the various types of cobweb discussed in the theorem?

A. Continuous cobwebs, divergent cobwebs, and convergent cobwebs.

Q. Nerlove's model basically deals with _____.

A. Nerlove's model basically deals with agricultural supply response.

Q. What is agricultural marketing system?

A. It is an efficient way by which the farmers can dispose their surplus produce at a fair and reasonable price.

Q. What are the different systems of agricultural marketing prevailing in India?

A. Sale in villages, sale in markets, sale in mandis and co-operative marketing.

Q. Marketable Surplus is a theoretical _____ concept.

A. Marketable Surplus is a theoretical ex ante concept.

Q. Marketed Surplus is a practical _____ concept.

A. Marketed Surplus is a practical ex-post concept

Q. What is the relation between marketable surpluses prices in the Mathur-Eizkel hypothesis?

A. Marketable surpluses are inversely related to prices in the Mathur-Eizkel hypothesis.

Q. Several explanations have been offered for _____ relationship between farm size and output per acre.

A. Several explanations have been offered for inverse relationship between farm size and output per acre.

Q. The negative relation may hold in _____ of the country at _____ but not everywhere and not yet all times.

A. The negative relation may hold in certain parts of the country at certain time but not everywhere and not yet all times.

Q. The initial price policy at the dawn of Independence was based on?

A. The initial price policy at the dawn of Independence was based on the plethora of controls exercised during the Second World War.

Q. How many crops were included in MSP?

A. 24 major crops.

7.16 Questions and Answers

7.16.1 Short-Answer Questions

Q. Explain the importance of CD production function.

A. It's Importance are given below:

1. It has been used widely in empirical studies of manufacturing industries and in inter-industry comparisons.

2. It is used to determine the relative shares of labour and capital in total output.

3. It is used to prove Euler's Theorem.

4. Its parameters α and β represent elasticity coefficients that are used for inter-sectoral comparisons.

5. This production function is linear homogeneous of degree one which shows constant returns to scale, If $\alpha + \beta = 1$, there are increasing returns to scale and if $\alpha + \beta < 1$, there are diminishing returns to scale.

6. Economists have extended this production function to more than two variables.

Q. Explain the concept of decision-making for agriculture.

A. Unlike decision-making at the farm level, which involves relatively straightforward criteria, decision-making for agriculture involves a variety of criteria, some relatively simple and others complex, some of immediate import and others of long term significance. In addition, there are policy decisions which are made with a focus on quite other matters (e.g., general economic policy measures) but have their effects on agriculture. Some of the less difficult, although quite important decisions for agriculture would be those relating to improvement of the information and security systems, which would help decision-making at the farm level in becoming more efficient.

Q. What are the three assumptions of Cobweb Theorem?

A. Three assumptions of the theorem are:

7. Perfect competition in which each producer assumes that present prices will continue and that his own production plans will not affect the market,

2. Price is completely a function of the preceding period's supply

3. The commodity concerned is perishable.

Q. Suggest some remedial measures for improvement of agricultural marketing in India

A. The following are some of the measures to be followed for improving the existing system of agricultural marketing in the country: Establishment of regulated markets; Establishment of co-operative marketing societies; Extension and construction of additional storage and warehousing facilities for agricultural produce of the farmers; Expansion of market yards and other allied facilities for the new and existing markets; Provision is made for extending adequate amount of credit facilities to the farmers; Timely supply of marketing information's to the farmers;

Improvement and extension of road and transportation facilities for connecting the villages with mandis; Provision for standardization and grading of the produce for ensuring good quality to the consumers and better prices for the farmers and Formulating suitable

agricultural price policy by the Government for making a provision for remunerative prices of agricultural produce of the country.

Q How the marketable surplus is computed?

A. It is computed by the formula MS = A – B

Where MS is Marketable Surplus, A - stands for net availability of the given crop in the year of reference and B - stands for the following items in the same year: (i) Consumption by the farm family, (ii) Consumption by permanent labour engaged on the farm, (iii) Consumption by the temporary labour occasionally employed on the farm, (iv) Quantity retained for seed, (v) Quantity retained as feed for farm animals, (vi) Quantity retained for barter, (vii) Payments in kind: a. to permanent labour, b. to temporary labour, c. for machinery and equipment, d. for customary payments, e. to land owners as rent, f. to land owners as share of produce, g. for re-payment of loan, h. land revenue, i. irrigation charges, and j. others. (viii) Physical losses: a. in threshing and winnowing, b. in transport from threshing floor to storage, and c. in storage at producer's level.

Q. What are the disadvantages of the Minimum Support Price.

A. the main disadvantages are:

I. To increase the income of the farmers, the poor of the country have to pay more. This practice will create the problem to allocate inefficiency in the country.

II. Subsidizing farmers through higher product prices is an inefficient method because it penalizes the consumer with higher prices. Also it means large farmers will benefit the most. They have received more than they need but small farmers are still struggling.

III. Farmers use fertilizers in the huge quantity to increase their production but it creates problems for those peoples who do not get benefits from this increment in the production.

7.16.2 Long-Answer Questions

Q. Explain the criticisms of C-D production function.

The C-D production function has been criticized on the following ground:

7. The C-D production function considers only two inputs, labour and capital, and neglects some important inputs, like raw materials, which are used in production. It is, therefore, not possible to generalize this function to more than two inputs.

2. In the C-D production function, the problem of measurement of capital arises because it takes only the quantity of capital available for production. But the full use of the available capital can be made only in periods of full employment. This is unrealistic because no economy is always fully employed.

3 The C-D production function is criticised because it shows constant returns to scale. But constant returns to scale are not an truth, for either increasing or decreasing returns to scale are applicable to production.

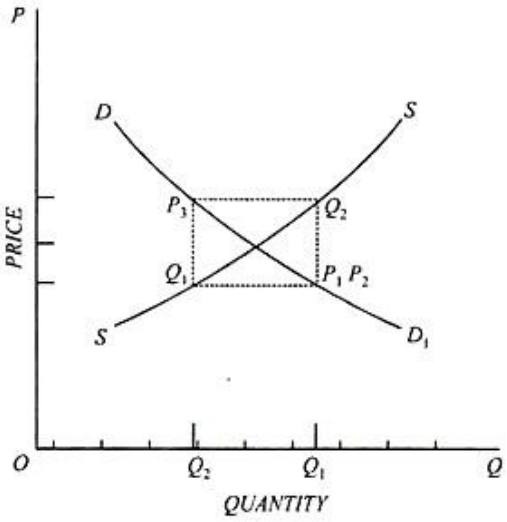
4. The C-D production function is based on the assumption of substitutability of factors and neglects the complementarity of factors.

5. This function is based on the assumption of perfect competition in the factor market which is unrealistic. If, however, this assumption is dropped, the coefficients α and β do not represent factor shares.

6. One of the weaknesses of C-D function is the aggregation problem. This problem arises when this function is applied to every firm in an industry and to the entire industry. In this situation, there will be many production functions of low or high aggregation. Thus the C-D function does not measure what it aims at measuring.

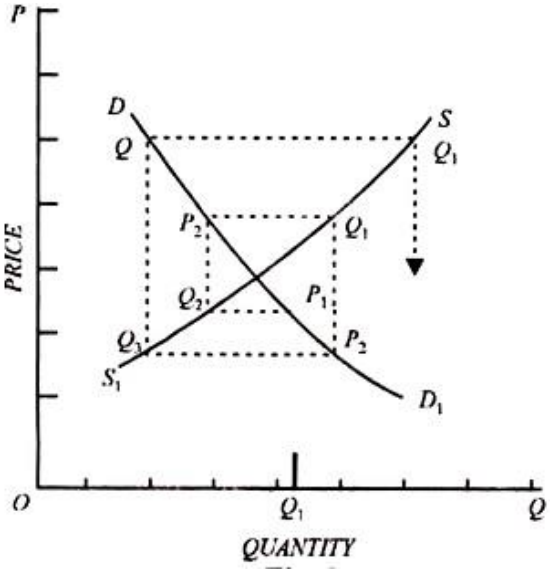
Q. Explain continuous cobwebs.

A. Where the elasticity of supply is equal to the elasticity of demand the series of reactions works out as shown in the Figure below. The quantity in the initial, period (Q_1) is large, producing a relatively low price where it intersects the demand curve at P_7. This low price, intersecting the supply curve calls forth in the next period a relatively short supply Q_2. This short supply gives a high price, P_2 where it intersects the supply curve. This high price calls forth a corresponding increased production Q_3, in the third, with a corresponding low price, P_3. Since this low price in the third period is identical with that in the first, the production and price in the fourth, fifth, and subsequent periods will continue to rotate around the path Q_2, P_2, Q_3, P_3 etc. As long as price is completely determined by the current supply, and supply is completely determined by the preceding price, fluctuation in price and production will continue in this unchanging pattern indefinitely, without an equilibrium being approached or reached. This is true in this particular case because, the demand curve is the exact reverse of the supply curve so that at their overlap each has the same elasticity. This case has been designated the “case of continuous fluctuations.”



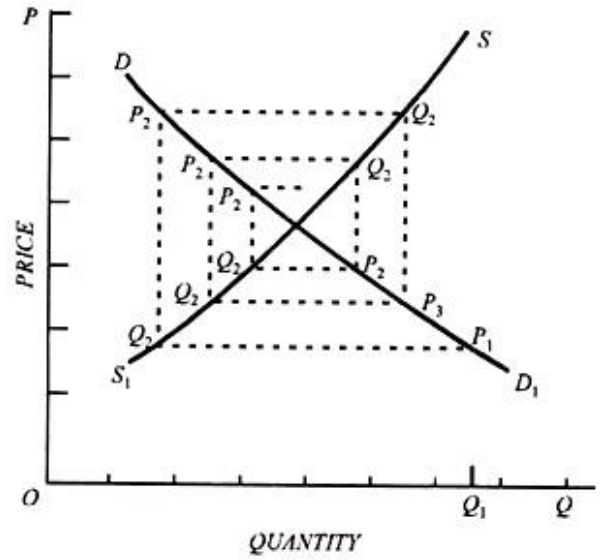
Q. Explain divergent cobweb.

A. Where the elasticity of supply is greater than the elasticity of demand, the series of reactions works out as shown in Figure below. Starting with the moderately large supply, Q_1 and the corresponding price P_1, the series of reactions is traced by the dotted line. In the second period, there is a moderately reduced supply, Q_2, with the corresponding higher price, P_2 . This high price calls forth a considerable increase in supply, Q_3 in the third period, with a resulting material reduction in price, to P_3. This is followed by a sharp reduction in quantity produced in the next period to Q_4, with a corresponding very high price, P_4. This fifth period sees a still greater expansion in supply to Q_5 etc. Under these conditions the situation might continue to grow more and more unstable, until price fell to absolute zero, or production was completely abandoned, or a limit was reached to available resources (where the elasticity of supply would change) so that production could no longer expand. The case has been designated the "case of divergent fluctuation."



Q. Explain convergent cobweb.

A. The reverse situation, with supply less elastic than demand, is shown in Fig. 3. Starting with a large supply and low price in the first period, P_1there would be a very short supply and high price, Q_2, and P_2, in the second period. Production would expand again in the third period to Q_3 but to a smaller production than that in the first period. This would set a moderately low price, P_3, in the third period, with a moderate reduction to Q_4 in the fourth period; and a moderately high price P_4. Continuing through Q_9, P_6 and Q_6, and P_6, production and price approach more and more closely to the equilibrium condition where further changes would occur. Of the three cases considered thus so far, only this one behaves in the manner assumed by equilibrium theory; and even it converges rapidly. If the supply curve is markedly less elastic than the demand curve. The case has been designated "the case of convergent fluctuation.



Q. Explain the criticism of cobweb theorem.

A. The Cobweb Theory too suffers from some severe limitations as given below:

7. This is not strictly a trade cycle theorem for it is concerned only with the farming sector. There are a good many others sphere of production where it says nothing.

2. This theorem assumes that the output is solely governed by price. Thus is unrealistic assumption. The fact is that the output particularly of farm products is determined not only by price, but by several other factors—weather, prices of the factors of production.

3. It is applicable only where: (a) The price is governed by the supply available, (b) When production is governed only by the considerations of price as wider perfect competition, and (c) When production cannot vary before the expiry of one full period.

4. The theory is based upon the unsound assumption that the crop which farmer plants in 2008 depends solely on the prices ruling in 2007. As a matter of fact this is contrary to facts. When 2007 prices undoubtedly influence decisions regarding 2008 crops, producers are also influenced by their expectations. Producer's decisions with regard production during any given period depend not only upon the backward look but also on the forward guess. If this year's price is high, producers are apt to foresee some reaction to the high price and anticipate larger output by their competitors next year.

5. This theory of trade cycle suffers from another weakness too. If we look at the Fig showing the diverging cobweb cycle, we find that disequilibrium once began continues indefinitely. The curves show that once the equilibrium is upset, the system falls into a series of unending cycles. In practice, however, this is most unlikely to happen. Commonsense tells that it cannot happen. In practice the shape of the curves is such as to make continued divergence impossible.
6. It can also be argued that even the constant type of cobweb cycle would not continue indefinitely.

Q. Explain the present state of agricultural marketing in India.
A. In India four different systems of agricultural marketing are prevailing:
Sale in Villages: The first method open to the farmers in India is to sell away their surplus produce to the village moneylenders and traders at a very low price. The moneylender and traders may buy independently or work as an agent of a bigger merchant of the nearly mandi. In India more than 50 per cent of the agricultural produce is sold in these village markets in the absence of organized markets.
Sale in Markets: The second method of disposing surplus of the Indian farmers is to sell their produce in the weekly village markets popularly known as 'hat' or in annual fairs.
Sale in Mandis: The third form of agricultural marketing in India is to sell the surplus produce though mandis located in various small and large towns. There are nearly 1700 mandis which are spread all over the country. As these mandis are located in a distant place, thus the farmers will have to carry their produce to the mandi and sell those produce to the wholesalers with the help of brokers or 'dalals'. These wholesalers of mahajans again sell those farm produce to the mills and factories and to the retailers who in turn sell these goods to the consumers directly in the retail markets.
Co-operative Marketing: The fourth form of marketing is the co-operative marketing where marketing societies are formed by farmers to sell the output collectively to take the advantage of collective bargaining for obtaining a better price.

Q. what are the defects of agricultural marketing in India.
A. Following are some of the main defects of the agricultural marketing in India:
Lack of Storage Facility: There is no proper storage or warehousing facilities for farmers in the villages where they can store their agriculture produce. Every year 15 to 30 per cent of the agricultural produce is damaged either by rats or rains due to the absence of proper storage facilities.
Distress Sale: Most of the Indian farmers are very poor and thus have no capacity to wait for better price of his produce in the absence of proper credit facilities. Farmers often have to go for even distress sale of their output to the village moneylenders-cum-traders at a very poor price.
Lack of Transportation: In the absence of proper road transportation facilities in the rural areas, Indian farmers cannot reach nearby mandis to sell their produce at a fair price. Thus, they prefer to sell their produce at the village markets itself.
Unfavorable Mandis: The conditions of the mandis are also not at all favorable to the farmers. In the mandis, the farmers have to wait for disposing their produce for which there is

no storage facilities. Thus, the farmers will have to lake help of the middleman or dalal who lake away a major share of the profit, and finalizes the deal either in his favour or in favour of arhatiya or wholesalers.

Intermediaries: A large number of intermediaries exist between the cultivator and the consumer. All these middlemen and dalals claim a good amount of margin and thus reduce the returns of the cultivators.

Unregulated Market's: There are huge numbers of unregulated markets which adopt various malpractices. Prevalence of false weights and measures and lack of grading and standardization of products in village markets in India are always going against the interest of ignorant, small and poor farmers.

Lack of Market Intelligence: There is absence of market intelligence or information system in India. Indian farmers are not aware of the ruling prices of their produce prevailing in big markets. Thus, they have to accept any un-remunerative price for their produce as offered by traders or middlemen.

Lack of Organization: There is lack of collective organization on the part of Indian farmers. A very small amount of marketable surplus is being brought to the markets by a huge number of small farmers leading to a high transportation cost.

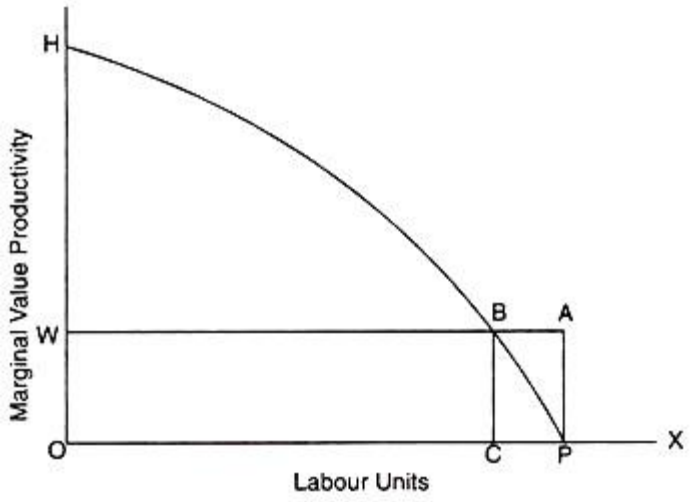
Lack of Grading: Indian farmers do not give importance to grading of their produce. They hesitate to separate the qualitatively good crops from bad crops. Therefore, they fail to fetch a good price of their quality product.

Lack of Institutional Finance: In the absence of adequate institutional finance, Indian farmers have to come under the clutches of traders and moneylenders for taking loan. After harvest they have to sell their produce to those moneylenders at unfavorable terms.

Unfavorable Conditions: Farmers are marketing their product under advice circumstances. A huge number of small and marginal farmers are forced by the rich farmers, traders and moneylenders to fall into their trap to go for distress sale of their produce by involving them into a vicious circle of indebtedness. All these worsen the income distribution pattern of the village economy of the country.

Q. Explain the relationship between farm size and productivity.

A. The Farm Management Studies conducted by the Ministry of Food and Agriculture in certain selected regions of India in the mid-1950s clearly revealed that output per acre declined with the increase in the size of holding. Several explanations have been offered for this inverse relationship between farm size and output per acre. The most important explanation advanced in this regard, is in terms of the low opportunity cost of family labour and the resultant variations in the amount of labour input used on different size classes of farms. It is based on the argument that the smaller farms, characterized by peasant family cultivation, extend the input of labour right up to the point where the marginal product of labour is zero (i.e., point P in the figure given below) or at least much below the ruling market wage rate. On the larger farms, the use of hired labour stops at the level (OC in the diagram) where its marginal product equals the market wage. Hence the smaller farms have higher.



The inverse relationship between farm size and productivity was claimed by many to be a confirmed phenomenon in traditional agriculture during 1950's. Under the impact of the new technology which is essentially capital-based (compared with the labour based technology of the traditional agriculture), the productivity advantage hitherto enjoyed by the small farmers with relative abundance of family labour started moving in favour of the large farms which have relative abundance of land also a more easy access to capital. There is strong evidence that after green revolution in India, the inverse relationship started yielding place to at least a 'constant' relationship if not a positive relationship between farm size and productivity.

7.17 Further Reading/ Suggested Readings

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Bardhan, P.K., *Interlocking Factor Markets and Agrarian Development: A Review of Issues*, Oxford Economic Paper, Vol- 32, No., 1980.
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UNIT –VIII
THEORIES OF AGRICULTURAL DEVELOPMENT

Structure

8.0 Introduction

This unit deals with the various theories of agricultural development. The important theories discussed in this unit are Lewis theory, Jorgensen's model. These theories discuss the problems of labour surplus economy. Lewis theory in particular assumes that the underdeveloped countries have surplus labour in the sense that marginal productivity of labour is zero. He calls for transferring of labour from agricultural sector to industrial for economic development. Jorgenson model emphasizes on the need to generate agriculture for transfer of labour from agriculture to industrial sector. He also discusses the importance of capital formation in the process of development of a dual economy.

The unit also contains theories which suggest the ways and means of transforming traditional agriculture. The theories of agricultural development are propounded by Schultz, Mellor and Boserup. The various theories of farm household behavior presented in this unit are Chayanov, Barnum-Squire and Lewis models.

The various theories of agricultural development are discussed as follows.

8.1 Objective

The objective of this unit is to provide knowledge about the various theories of agricultural development which are applicable to underdeveloped countries.

8.2 Lewis Model

The Lewis model of development focuses on the structural transformation of a primarily subsistence economy through the process of surplus labour from subsistence agricultural sector to modern urban industrial sector. The theory was developed by Nobel laureate W. Arthur Lewis in 1954. It became the general theory of development process in labour surplus third world nations during the 1960s and early 1970s.

The theory is based on the following assumptions:

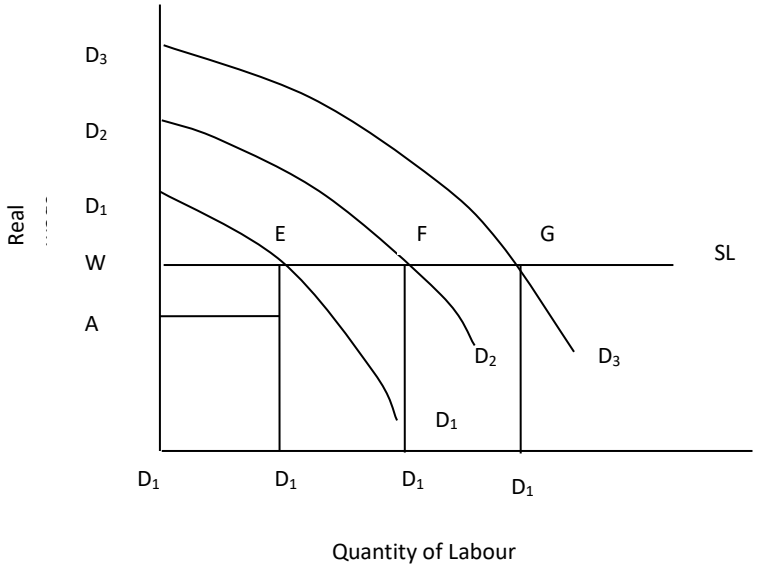
1. The economy consists of two sectors;
   a) Traditional subsistence agriculture sector and
   b) Modern urban industrial sector
2. The traditional sector is over-populated with zero marginal productivity of labour.
3. Modern industrial sector is characterized by high productivity.
4. The subsistence sector does not make the use of reproducible capital while the modern sector was capital.
5. The supply of labour to industrial sector is perfectly elastic.

Given these assumptions, Lewis argues that economic development can take place in such a labour surplus economy through the process of transfer of surplus labour from the insistence agriculture sector to modern urban industrial sector at the constant urban wage rate. The wage rate in urban industrial sector remains constant so long as the supply of is perfectly elastic. The labour, who were having zero marginal productivity in the traditional sector can be gainfully employed in the industrial sector where they will contribute positively and earn wage rate equal to their marginal productivity.

The labour transfer and modern sector employment growth depend on output expansion in the modern sector. The speed at which the modern sector expands is determined

by the rate of investment and capital accumulation in the modern sector. It is assumed that capitalists reinvest all their profits and reinvestment profits leads to capital accumulation and expansion of output and employment in modern sector. However, there are certain bottlenecks in the transfer of labour from subsistence sector to modern industrial sector. Firstly, labour may be reluctant to move to urban industrial sector from employment due to their long term association with land, relatives and home. Secondly, the capitalist sector needs skilled labour but most of the workers in traditional sector are unskilled. However, Lewis argued that skilled labour is only a temporary bottleneck. It can be solved by giving training to unskilled labour. Further, he argues that urban wage rate should be at least 30% higher than the average rural income to induce workers to migrate from the traditional agriculture sector to modern sector.

At the constant urban wage, the supply curve of labour to the modern industrial sector is perfectly elastic.



The Lewis model of development of a two –sector economy can be illustrated as follows:

In the figure, the quantity of labour is ensured along the horizontal axis and real wage is measured along the vertical axis. OA is the average rural income and OW is the urban quantity of labour industrial wage rate.

It assumed that OW is at least 30% higher than OA. D_1D_1, D_2D_2 and D_3D_3 are the demand curve for labour in the industrial sector. SL is the supply curve of labour to the modern industrial sector. According to Lewis, there is surplus labour in the traditional sector, in the

sense that marginal productivity of labour is zero and rural read wage is determined by the average product.

Initially the demand curve for labour in the modern sector is D_1D_1which is also the marginal product curve of labour. The modern profit-maximizing sector, initially hires OL_1, i.e. to point were their marginal product is equal to real wage. In figure, demand curve for labour D_1D_1intersects the labour supply curve at point E, corresponding to which the total modern sector employment is equal to OL_1. The total output of modern Sector would be given by the OD_1EL_1. The total wage bill would be $OWEL_1$. The total profits of the capitalist would be equal to the area WD_1E. The capitalist would reinvest the entire profits. The reinvestment of profits by the capitalists would increase the total stock of capital and this would shift the demand curve for labour to D_2D_2. A new equilibrium will be achieved at point F will OL_2 workers employed. As a result, the total output rises to OD_2FL_2. The total wages and profits increase to $OWFL_2$ and WD_2F respectively. The capitalist will reinvest the entire profits which further increases the stock of capital and shifts the labour demand curve to D_3D_3. The result is that there is further increase in employment and income in modern industrial sector. The new equilibrium takes place at point G at which the level of employment is OL_3 and total income is OD_3GL_3. The wages and profits increases to OWGL3 and WD_3G. The reinvestment of this profit by the capitalist leads to further expansion of output and employment and promote development of a dual economy.

The above process of growth of modern industrial sector and employment expansion will continue until all surplus labour from the traditional sector is absorbed in the industrial sector. After the exhaustion of surplus labour, additional workers can be withdrawn from the agricultural sector only at a higher wage rate. The supply curve of labour will become positively sloped and wages and employment in modern sector will go hand in hand. The structural transformation of the economy will have taken place by this time.

8.2.1 Criticism of the Lewis model

Although the Lewis theory is very interesting as it has explained the process of development of a labour surplus economy in a simple and attractive way, the theory suffers from certain drawbacks.

1. **Labour saving capital accumulation**: The theory assumes that the capitalists will reinvest their profits which head to expansion of output and employment in the modern sector. But if the capitalist reinvest their profits in more sophisticated labour-saving capital equipment or technology, it would not lead to expansion of

employment. This kind of reinvestment of profits will lead to rise in only output and capitalists profits. If this is the case, the whole theory breaks down.

2. **Urban wage rate not constant:** The theory assumes that wage rate in urban industrial sector is constant until the supply of labour is exhausted from the subsistence sector. This is unrealistic as urban wage continues to rise due to pressure from powerful workers union.
3. **Capital Flight:** The theory assumed that the capitalist would reinvest their profits within the domestic economy. So the theory argued that the reinvestment of profits would lead to expansion of output and employment. But if the capitalists tend their profits abroad as a form of capital flight then the expansion of output and employment will not take place in the domestic economy.
4. **Skilled Labour not a Temporary Bottleneck:** Lewis assumes that unskilled labour can be given training and skill can be formed. So he considered skilled labour as temporary bottleneck. However, skill formation poses as serious problem and it takes a long time and high cost to train the unskilled workers.
5. **Marginal productivity of labour not zero:** The theory assumes that marginal productivity of labour is zero in subsistence sector of overpopulated underdeveloped countries. But T.W. Schultz does not agree with Lewis and opined that marginal productivity may be low but not zero.

8.2.2 Conclusion

Despite these criticisms, the Lewis theory is extremely valuable as an early conceptual portrayal of the development process through the transfer of surplus labour from the subsistence sector to modern industrial sector. It has explained the process of structural transformation of labour surplus underdeveloped countries in a very clear and simple manner. It explains how capital accumulation can take place in such an economy with reinvestment of profits by capitalists which help in growth of the economy and expansion of employment and output. But the theory needs certain modifications in assumptions and analysis to fit the reality.

8.3 Jorgenson's Model

D. W. Jorgenson presented a theory of development of a dual economy in 1961. According to him, an underdeveloped economy consists of two sectors- the modern manufacturing sector and the traditional agricultural sector. The development of economy

depends on the rate of investment in manufacturing sector and transfer of labour from traditional sector to modern sector. However, the supply of labour form traditional agricultural sector to modern sector depends on agricultural surplus. In this model, population growth depends on supply of food per capita. So, agricultural surplus exists when food supply is more than sufficient of the population. Labour is free for employment in modern sector only when agricultural surplus is positive. The supply labour force to the manufacturing sector grows at a rate which is equal to the growth rate of the agricultural surplus. Labour may demand higher wage rate in the modern sector. So there may be some wage differential between the two sectors which is proportional to the wage rate in the modern sector. The wage differential determines the terms of trade between the two sectors.

Assumptions of the model

1. Thereare two sectors in the economy- the traditional agricultural sector and modern manufacturing sector.
2. Land is fixed in supply
3. Output of the agricultural sector is a function of land and labour.
4. Output of the manufacturing sector is a function of capital and labour.
5. Agricultural production is subject to diminishing returns to scale.
6. Manufacturing production is subject to constant returns to scale.
7. Technical changes are neutral and take place t some constant rate.
8. The economy is a closed one.

Given these assumptions, the process of development of dual economy is explained as follows:

First of all, the model explains the production function of agricultural sector.

Agricultural Sector

The production behavior of agricultural sector is given by the Cobb-Dougles production function:

$$Y = e^{\propto t} N^{\beta} L^{1-\beta} - - - -(1)$$

Where, Y represents agricultural output; $e^{\propto t}$ is the technical change which takes place at $\propto$ rate in the time t. N is quantity of land; β is the share of landlords in the output and (1-β) is the share of labour, L is the total labour in this sector.

Since land (N) is assumed to be fixed in supply, equation (1) can be written as ;

$Y = e^{\propto t} C.L^{1-\beta} - - - -(2)$

Where $C = N^{\beta}$

The average output per man can be obtained by dividing both sides of equation (2) by L, and we have

$$Y/_L = \frac{e^{\alpha t} C.L^{1-\beta}}{L}$$

$$Or,$$

$$Y = e^{\propto t} C.L^{-\beta}$$

Now taking log on both sides, we have

$Log\ Y = Log\ e^{\propto t} + Log\ C + Log\ L^{-\beta}$

$Log\ Y = \alpha t + 0 + (-\beta) Log\ L$

$Log\ Y = \alpha t + \beta\ Log\ L$

Now, differentiating with respect to time, we get

$$\dot{Y}/_Y = \alpha - \beta \frac{\dot{L}}{L}$$

$$\dot{Y}/_Y = \alpha - \beta \in - - - - (3)$$

Where α the rate of technical progress is, β is the share of landlord in output and $\in$ in the net reproduction rate.

The equation (3) sows that the relative growth rate of per capita output in agricultural sector is equal to the difference between the rate of technical progress and the product of the relative share of landlord in total output and growth rate of workforce. The relative growth of per capital output will be positive only when $\alpha > \beta \in$. The equation (3) states that the technical progress is important to develop backward agricultural sector. At the same time, efforts should be made to reduce net reproduction rate.

Agricultural surplus will arise only when per capita output will constantly rise. Agricultural surplus can be represented as

$\delta = y - y^*$

Where, δ is the agricultural surplus per capita, y is average output per man and y* is the level of per capita output at which net reproduction rate is maximum.

If the agricultural surplus is positive, then only labour force can be transferred from the tradition agricultural sector for employment in the manufacturing sector. On the other hand, if the agricultural surplus in zero, all labour will remain on land and the system will be

in low level equilibrium trap. According to this model, agricultural surplus must be positive for development of a dual economy.

Manufacturing sector

When the agricultural sector,intereststo generate agricultural surplus, then the labour force get transferred to the manufacturing sector. This lends to increase in production and capital accumulation in the manufacturing sector. Now, the production function in the manufacturing sector can be explained as follows:

X = f (K, M) --- (4)

Where, X is the output, K is the capital stock ad M is the labour force.

The above function can be written in Cobb—Douglas production function as –

X = $K^{\sigma}M^{1-\sigma}$ ----(5)

Where is the technical progress, σ is the share of capitalist and $1-\sigma$ is the relative share of labour.

The average output per man in manufacturing sector is given by -

$\frac{X}{M} = \frac{e^{\partial t}K^{\sigma}M^{1-\sigma}}{M}$

$or\ x = e^{\partial t}K^{\sigma}M^{-\sigma}$

$Or, x = e^{\partial t}(\frac{K}{M})^{\sigma}$

$or\ x = e^{\partial t}K^{\sigma}$------ (6)

This is the technical progress function which shows that output per man in manufacturing sector is a function of capital per man.

According to Jorgenson, the rate of capital accumulation depends on the rate of investment by capitalists. He assumes that industrial workers do not save and capitalists do not consume out of their property income so the consumption of manufacturing goods in both sectors is equal to the share of labour in the output of the manufacturing sector. the remain share of output goes to the capitalists which are fully invested for further expansion and growth. The wage rate in the manufacturing sector is determined by the marginal productivity of labour.

Given,

$X = e^{\partial t}K^{\sigma}M^{1-\sigma}$

Marginal productivity of labour is equal to

$$\frac{\sigma X}{\sigma M} = e^{\partial t} K^{\sigma} \frac{\partial M^{1-\sigma}}{\partial X}$$

$$= e^{\partial t} K^{\sigma} (1-\sigma) M^{-\sigma}$$

$$= e^{\partial t} (K/_{M})^{\sigma} (1-\sigma)$$

$$= e^{\partial t} K^{\sigma} (1-\sigma)$$

Substituting

$x = e^{\partial t} K^{\sigma}$ *from equation* 6,

We have

$$\frac{\partial X}{\partial M} = x(1-\sigma) = w - - - -(7)$$

Where x is the per capita output and W is the wage rate in manufacturing sector. The necessary condition for profit maximization is that the rate should be equal to the marginal product of labour.

the wage differential between the two sectors is denoted by μ.

μ = y/w

Or, y = μ.w

Thus, the total wage bill in the economy will be –

wM + μ.w.L = (1- σ) XM + μ.w L

Or, wM + μ.w L $= (1-\sigma)\frac{X}{M}.M + \mu.wL$

Or, wM + μ.w L = (1-6) X + qY

Where qY is the value of agricultural output measured in terms of manufactured goods. The variable q is the terms of trade between agriculture and industry.

Jorgenson defines capital accumulation as investment less depreciation. Depreciation is considered to be a constant fraction of capital stock. The rate of change in capital stock is defined as –

$\dot{K}$ = I – nK

I = $\dot{K}$ + nK --- (8)

Where n is the rate of depreciation, I is gross investment and K is the capital stock.

The total output of manufacturing sector is equal to the sum of consumption and investment

X = (1- σ) X + I --- (9)

Now, substituting equation (8) in equation (9) we get

X = (1- σ) X + $\dot{K}$ + nK

Or, X = X- σX + $\dot{K}$ + nK

Or, $\sigma X = \dot{K}$ + nK ---- (10)

In equation (10) σX represents saving and $\dot{K}$ + nK represents gross investment.

By using production function to replace X, we get

$\sigma e^{\partial t} K^{\sigma} M^{1-\sigma} = K + \dot{nK} \quad ---(11)$

This is the fundamental equation for the development of a dual economy. It shows that growth of the economy is determined by the rte of savings and capital accumulation.

8.3.1 Criticisms

The model has been criticized on the following grounds:

1. **Rules out capital accumulation in agriculture sector**: The model rules out the possibility of capital accumulation in agriculture sector. This is unrealistic as there are many studies which have shown rapid increase in labour productivity and farm production due to capital accumulation in agriculture.
2. **Supply of land not fixed:** the model assumes the supply of land as fixed in agricultural production. This is not acceptable as the supply of land can be increased through land reforms and land reclamation.
3. **Neglects Demand side factors:** The model emphasizes only on the role of supply side factors such as labour, capital and technical progress and neglects the demand side factors.
4. **Ignores service sector:** The model also ignores the service sector which also play important role in the process of development of a dual economy. In fact, it is te service sector which has which has been growing rapidly and propelling development in contemporary period.

8.3.2 Conclusion

The model has put forwarded the conditions necessary for growth and development of a dual economy. It states that there is a need to have positive and growing agricultural surplus then only labour force will be face for employment in the manufacturing sector. The conditions necessary for sustained growth of output is that technical progress should be positive and there should be higher rte capital accumulation.

8.4 Theories of Agricultural Development: Schultzian Theory

The development of agriculture is important for over-all development of an economy. Therefore, many economists have developed various theories suggesting ways and means for development of agriculture in underdeveloped countries. In this regard, T.W Schultz has made a significant contribution.

Schultz, in his books 'Transforming Traditional agriculture which was published in 1964, has suggested various ways and means to develop traditional agriculture. In his theory, he discusses some important aspects of the problem of transformation of traditional agriculture. Schultz's theory of agricultural transformation can be discussed under the following heads.

8.4.1 Definition of Traditional Agriculture

The definition of traditional agriculture given by Schultz is different from the definition given by other economists. According to Schultz, traditional agriculture is one which is static and non-dynamic. Agriculture can be capital intensive as well as productive yet it can be traditional in character, if its art of cultivation is static and further development does not take place. In that sense, even the agriculture of developed countries like America can be traditional if the art of cultivation does not change and become stagnant. To Schultz traditional agriculture is not necessarily a backward and labour intensive agriculture. He wanted that even capital intensive agriculture can assume traditional character in the long period and eventually arrive at the equilibrium where the art of cultivation comes to a halt that characterizes traditional agriculture. The agriculture will remain traditional until the art of cultivation changes.

8.4.2 Characteristics of Traditional Agriculture

After defining the traditional agriculture in his own ways, Schultz discusses the two important characteristics of traditional agriculture which are as follows:

i. **Perfect allocation of resources:** According to Schultz, there is perfect allocation of resources in traditional agriculture. The static art of cultivation enables the farmers to know, by long experience, about the returns to various factors of production. So they will allocate resources and factors up to the point where the marginal returns of these factors are equal to their respective marginal costs i.e. (MR = M C). This is the condition for perfect allocation of resources. This conclusion leads to the poor but efficient hypothesis. This hypothesis states that the farmers in traditional agriculture

are generally poor because of stagnation of agriculture but due to long experience with the same art of cultivation, they are able to allocate resources efficiently.

ii. **No zero value labour:** Many economists have argued that in traditional agriculture marginal productivity of labour is zero. However, Schultz is of the view that there is no zero value labour in traditional agriculture. According to him, marginal productivity of labour in traditional agriculture may be low but not zero. To him, any withdrawal of labour from the traditional agriculture will lead to reduction in total output. He provided evidence to prove his argument. He cited examples from Latin American countries Peru and Brazil where labour was withdrawn from agricultu4re for engaging in construction activity. Schultz found that in both the countries withdrawal of labour from agriculture resulted to decline in agricultural production. Thus, Schultz concludes that marginal productivity of labour in traditional agriculture is positive and not zero.

8.4.3 Schultz's Suggestions for Transforming Agriculture

Traditional agriculture, according to Schultz, is in equilibrium with static art of cultivation. The traditional agriculture can be transformed by introducing new factors which are more productive than the existing ones. According to him there is a need to create new investment opportunities in agriculture and the art of cultivation should be changed. It implies that agricultural transformation can be achieved only with a etymological transformation which constitutes new factors of production, new methods and new skills.

Schultz's suggestions are described as follows:

1. **Policy approach**: According to Schultz, there are two policy approaches which can be adopted to faster the use of new factors by the farmers. These are: market approach and command approach. In the market approach farmers are given freedom to decide about the adoption of new inputs. They are allowed to take decision based on profitability of new factors. The role of government is confined to development and distribution of new inputs, development of skills, publicity, provisions of cheap credit etc. In this approach, farmers are not forced to adopt new inputs. They enjoy freedom to choose whether to adopt new inputs or not. Example, Mexico.

   On the other hand, under the command approach the farmers not free to decide regarding the use of new inputs. Everything is decided by the State. The State supplies the new inputs and directs the farmers to use them. The farmers have no choice, they

have to adopt the new inputs supplied by the state and in return, they have to give a portion of the output to the state example Russia.

2. **Transformation process**: The processes of transformation depend on the demand and supply of new factors production. The new factors should be more productive than the traditional factors and should available in the market at the same time; farmers should be willing to use such factors in their field.

   There are certain problems in supply of new factors, Schultz discusses those problems and makes suggestions which are as follows:

   i. **Supply of new factors**: There is a need to ensure supply of new factors in sufficient quantity and that too at reasonable prices. These are important for their effective use and ensure profitability.

      According to Schultz, three steps are involved in the process of supply of new inputs which are as follows:

      a) Research and development
      b) Distribution of new inputs to farmers and
      c) Extension services to disseminate knowledge for use of new inputs.

      According to Schultz, the research and development of new inputs should be done by the state because the private agencies may not have sufficient resources to undertake such activities. A private firm may not be willing to take up research and development as the benefits of such research cannot be retained and is likely to flow to other firms. So the research and development of new inputs should be carried out by the state or non-profit making agencies.

   ii. **Distribution of new inputs:** Once the new inputs have been developed, the next step is to build up necessary infrastructure for their distribution to farmers; Schultz suggests that in the initial stage there may be some difficulties in the distribution of new inputs. These difficulties include – limited demand, high cost, resistance from the supplies of traditional inputs etc. Therefore, we suggest that in the initial stage the distribution of new inputs should be undertaken by the State or nonprofit making agencies.

   iii. **Development of Extension services:** a well developed extension services is needed to import knowledge to farmers about the method for using new

inputs. Schultz argues that the extension work may be carried out by the state as it involves high cost.

iv. **Demand for new inputs:** Supply of new inputs alone is not sufficient for agricultural transformation. The new inputs must also be demanded by the farmers for use in their field. In other words, there is need to generate demand for new inputs.

According to Schultz, the demand for new inputs will depend on the profitability. The profitability, in turn, depends upon two factors

a) supply price of new inputs and
b) Prospective yield.

Schultz opines that in order to encourage the use of new inputs their supply price should be low. He suggests that in the initial stage, the government should supply new inputs at subsidized rates.

Apart from the supply price, the profitability of new inputs also depends on prospective yields. Since the inputs are new the farmers are uncertain about the yields from them. Therefore, the prospective yields of the new inputs should be high so as to convince the farmers to use them.

3. **Importance of skills in Agricultural Transformation:** Skins and knowledge are also important for the use of new inputs and agricultural transformation. Therefore, the farmers should be imported required knowledge about the use of new inputs. According to Schultz, skills can be formed in three ways –

i. trial and error method
ii. on the job training and short term and vocational courses
iii. schooling

To Schultz, schooling which impart the general education is the best form of investment and ways to build up human capital and form skills. He cited the example of Holland and Denmark where the rapid growth of agriculture in the last quarter of the19th century was associated with a large investment in schooling.

8.4.4 Criticisms

Schultz suggestions to transform traditional agriculture are, undoubtedly good and realistic. However, his theory suffers from certain infirmities.

i. **Definition of traditional agriculture not pragmatic:** The definition of traditional agriculture given by Schultz is not pragmatic and its implications have been challenged by many economists.

ii. **Market approach:** He favours market approach for agricultural transformation without assessing the economic reality of underdeveloped countries. In such economies markets are poorly organized and suffer from imperfections. Therefore, in the initial state, state may have to undertake and control activities.

iii. **Ignores institutional reforms:** Schultz has ignored the role of institutional reforms in the process of transformation of traditional agriculture.

iv. **Ignores differences among poor economies:** Schultz has also ignored the difference among the poor economies with regard to factor endowments, extent of monetization and administrative efficiency etc. The use of new inputs is affected by these differences which he did not consider.

v. **Neglect non-economic barriers:** Schultz has paid attention only to economic factors in the transformation of traditional agriculture. He has neglected non-economic barriers like religious belief, conservatism and fatalistic attitude of farmers which can act as barriers for adoption of new inputs.

Conclusions

Despite these criticisms, it can be concluded that Schultz has made important suggestions for transformation of traditional agriculture. His analysis will certainly be helpful in formulating policies for agricultural development. However, his suggestions will have to be adopted based on the social and economies conditions prevailing in the given poor economy.

8.5 Mellor's theory of Agricultural development

W.J. Mellor in his book entitled 'The Economics of Agricultural Development' which was published in 1966 suggested ways and means to transform traditional agriculture into modern agriculture.

According to Mellor, agriculture of an economy passes through three phases:

1. Traditional agriculture
2. Technologically dynamic agriculture- low capital technology and
3. Technologically dynamic agriculture- High capital technology

The main features of agriculture in these phases are described as follows:

8.5.1 Traditional Agriculture

Mellor defines traditional agriculture in a pragmatic way. According to him traditional agriculture is one which is backward, labour intensive agriculture with low productivity. Most of the farms in traditional agriculture are peasant farms in which bulk of labour force, management and capital are supplied by the same household. The farms are generally small in size and productivity production and net income tend to below. But there is a perfect allocation resource in such agriculture.

The principle inputs used in traditional agriculture are land and labour. The use of additional labour is the only source of increasing production and income. But the use of more labour on a given farm heads to diminishing marginal productivity.

Mellor pointed out that in traditional agriculture some non-traditional inputs like fertilizers may be used but their impact on total production will be negligible because of non-use of other complementary inputs like good seeds, pesticides etc. He viewed that both technological changes and institutional reforms are needed to transform traditional agriculture.

8.5.2 Characteristics of traditional agriculture

1. **Under-employment**: According to Mellor, there is under-employment in traditional agriculture. This is mainly due to inequality in the distribution of land. The farmers having bigger farms have the option to choose between leisure and work because of higher income. This lends to under-employment. But the farmers operating on small farms may have to use their labour up to the point where its marginal productivity becomes zero.

   According to Mellor, there are three types of income levels; these are as follows:

   i. Biologically subsistence level of income: It is the level of income which ensures only the biological subsistence, i.e., food, clothing, shelter and other essentials for maintaining human life.
   ii. Culturally defined subsistence level of income.
   iii. Income for a dynamic society

   The farms in traditional agriculture can be broadly of two types:

a) Farms which can provide the biological subsistence level of income and
b) Farms which can provide at the maximum, the culturally defined subsistence income.

In the first types of farms, labour will be used till its marginal productivity becomes zero. In the second type of farms, the equilibrium level use of labour will be determined by the tangency point of the production possibility curve for the given farm and is utility curves.

2. **Backward Sloping Supply Curve**: According to Mellor, the total supply curve for agricultural produce in traditional agriculture is backward sloping. This is due to negative income effects on use of labour when prices changes. The high prizes of agricultural produces encourage farmers to reduce leisure and use more labour (positive substitution). But when their income increases due to price size, then farmers will tend to work less (negative income effects). Thus, a point is reached when the negative income effect fully neutralizes the positive substitution effect on labour use and total production starts to fall and curve slopes backward.

3. **Impact of withdrawal of labour**: It is generally argued that there exists zero value labour in agriculture and its withdrawal will not reduce the total output. However, Mellor believed that any withdrawal of labour from the agriculture will result in a fall in output. This is because of increase in per capita income of remaining labours which causes the use of less labour.

Mellor viewed that traditional agriculture will not shed its traditional character if it is left undisturbed. The government has to formulate a policy which aimed to bring technological changes.

Technologically Dynamic agriculture – Low capital technology

In this phase, new inputs with high marginal productivity and complementary to labour are used in agriculture. The use of such inputs encourages the use of traditional inputs by raising their productivities. The new inputs are friendly to traditional inputs and do not replace them. Some of the new inputs are friendly to traditional inputs and do not replace them. Some of the new inputs are fertilizers, new seeds and power.

In this phase, agriculture still occupies the dominant place in the economy. Machinery is not used due to the availability of cheap labour.

According to Mellor, the following are necessary for smooth progress of this phase.

i. Institutional reforms
ii. Encouragement of research
iii. Supply of new and improved inputs
iv. Lifting up of institutions to service agricultural production.
v. Development of communication system
vi. Establishment of educational institutions to train people.

In this phase of agriculture development, new technology is used but it is not heavily capital oriented. The new inputs are complementary to labour.

Technologically Dynamic Agriculture- High Capital Technology

In this phase, the agriculture become highly capital intensive and uses new technology which is heavily capital oriented. This stage comes when the non-agriculture sector come into existence which create labour-saving mechanical innovations. In this agricultural sector, sufficient capital accumulation takes place. Size of farm also increases due to movement of people from agriculture to industrial sector. In this phase, heady investment takes place in agriculture in the form of machinery. In this phase, the new inputs replace labour from agriculture and increase the productivity of the labour which is left in the agriculture.

Mellor pointed out that the development of agriculture should follow these three phases for its smooth progress.

8.5.3 Critical Evaluation of Mellor's Theory

The definition of traditional agriculture given by Mellor is more pragmatic. He defines traditional agriculture as on which is a backward and uses labour as the main factor of production. He argues that if labour is withdrawn from that agriculture, agricultural production will fall. But he does not insist that there is no disguised unemployment in the agriculture sector. His suggestions for transformation of agriculture emphasis are on institutional changes like land reforms, marketing credit facilities. He favours government intervention for development of agriculture.

Mellor emphasises on the role of labour and other inputs in the process of development. In the traditional agriculture, output is increased by using more labour on land

till its marginal productivity become zero. But in dynamic agriculture new inputs are used which increases the productivity of labour.

8.6 Boserup's Theory of Agricultural Development

Ester Boserup, in her book 'The conditions of Agricultural Growth' which was published in 1966, discussed the problems and processes of agricultural development. According to her agricultural development takes place due to some kind of compulsion. The compulsion is that of growing population. It is the pressure of populationwhich causes the development of agriculture. She opined that the techniques of cultivation as well as the social structure of agrarian communities were governed by the growth of population. This contention was supported through an examination of agricultural development in some African and Latin American countries.

Boserup reputed the Malthusian Theory of population which state that if the food supply increases population will increase and wipe out the excess food supply. On the other hand, if the population is already beyond the level which can be sustained by the existing food supply, the population itself will decline through the positive check. Boserup refuted the first part of the Malthusian theory by saying that population growth depends not only on food supply but on medical inventions. She refuted the second part of the Theory by stating that if population has gone beyond the means of subsistence, it will not decline. The pressure of population will lead to various technical innovations which results in increase in food supply. This happens, especially in the early stages of agricultural development when there is a need to support large population from the given land area.

8.6.1 Stages of Agricultural Development

After discussing the factor propelling agricultural development, she explains the various stages of agricultural development. According to her, agricultural development in any country passes through five stages. These stages of agricultural development are discussed as follows:

i. **Forest fallow stage**: In this stage, a country was generally convened with forests. So people had to clear forest to prepare land for cultivation. The forests are burnt down

which makes the soil loose and fertile. Hence, there is no need to plough the soil and apply manure. In this stage, the amount of labour and capital required cultivation is less. The only tools needed for cultivation are axe and sticks. In this stage, population is quite sparse and land is plenty in supply. So, people can leave the land to be fallow for a long period. The fallow period would be up to 25 years.

ii. **Bush fallow stage**: In the second stage population growth increase the demand for food and its food requirements are not fulfilled by the agricultural practice involving burning of matured forests. Thus, the population pressure forces the people to resort to the burning of bushes to bring more area under cultivation. This leads to reduction in fallow period to 6 years. When the bushes are burnt many roods and weeds cannot be completely burnt by the fire. The soil become compact so there is a need for hoe and more labour in agricultural operations. Labour will be needed loosening soil and also of weeding purpose.

iii. **Short fallow stage**: The growth of population further increases the ened for food grains. This pushes the agriculture into the 'short fallow' stage. In this stage, the society cannot leave the land as fallow for long period. Now land under grasses and weeds are also brought under cultivation. The burning of grasses cannot burn the weeds fully and soil also remains compact and hard. It also does not add much to soil fertility. Hence, there is a need to use plough to till the soil and apply dung pond mud, litter etc. as manure. This requires more labour and also more capital. The fallow period goes down to a year or two years.

iv. **Annual cropping stage**: Further, growth of population takes the agriculture to annual cropping stage. In this stage, there is no fallow. The land is cultivated every year. This is a type of annual rotational system. Hence, in this stage, more labour capital and manure are needed in agricultural operation.

v. **Multiple cropping stages**: If the population grows further, then the agriculture enters the multiple cropping stage. This stage marks the most intensive use of land. In this stage, fallow period is negligible as the same land cultivated to grow two or more crops every year. As soon as one crop is harvest, the same land is prepared to sow another crop. There is a need for more capital and labour compared to the earlier stages. Since the land is used intensively, simple manuring will be enough to maintain soil nutrients. There is a need for green manuring, compost, flit etc. Multiple cropping will also need irrigation facilities water the plants.

Thus, Boserup stressed that in the preindustrial stages population growth does not create any obstacles for agricultural development. In fact, the population growth encourages investment in rising of new fields, irrigation work, drainage and canals etc. and promotes agricultural development. Her assertions have been supported by same research works. Simon and R. H Choudhary found a positive impact of population growth on agricultural development.

8.6.2 Criticisms

Boserup has very clearly explained the problems and process of agricultural development. However, her theory suffers from a few analytical pitfalls and also it is not quite relevant for present under-developed countries. The Theory has been criticized on following grounds.

1. The theory is totally irrelevant to those economies where the urban industrial sector is well developed like USA. The Theory fails to explain how agricultural development took place in the pre-industrial when the pressure of population was low. At the same time, it fails to explain, why over populated countries in Asia and Africa could not develop in agriculture and industrial sector despite having huge population pressure.
2. Boserup believed that in underdeveloped countries growing population can be absorbed in the agricultural sector even when there is a large scale machination due to multiple cropping. However, the growing unemployment in the agriculture sector in the developing countries like India showed that agriculture development has failed to absorb growing population.
3. In her theory, Boserup pointed out that cultivation becomes more intensive when population increases and become extensive when population comes down. But her assertion is not fully convincing. The sequence of intensification of cultivation, technical, institutional and social set-up is not totally reversible.
4. The theory is based on a closed economy so it does not apply to the modern day under-developed economies which are open to great extent. Thus, the agriculture is not likely to pass through the stages of development as described by her. The agriculture can directly move from forest fallow stage to the multiple cropping stages when the economy opens up.
5. The Theory applies only in a situation where population is parsing and land in plenty. It is not applicable in the present day underdeveloped countries where land frontiers

have reached. On such countries increase in agricultural output will depend only upon the scientific discovery which is missing in the Boserup theory.

6. Population growth also has unfavorable effects on the development of agriculture. But Boserup has ignored this fact. The growth in population result in fragmentation of holdings and the size of holdings falls. The small holdings are usually unsuitable for adoption of new technology. Hence, population growth may adversely affect the process of capital formation.

Despite, these criticisms, it can be concluded that Boserup has made a significant contribution to the theory of agricultural development. There are some studies which have found Boserup's assertion to be true. For example, R.H Choudhary found a positive correlation between growing population and agricultural development. Conlisk, Hudle and Simon also support Boserup's findings. Kuznets also extends indirect support to Boserup. However, the studies by Thirwall and Levi do not support her theory. Thus, we can concluded that the relationship between population and agricultural development is quite complex as both influence each other. Further, there are social, economic and technical factors which influence both the variables.

8.7 The Chayanov Farm Household model

A V Chayanov, the Russian agricultural economist advanced the first analysis of peasant household's economic behavior in 1920s. His model is based on the followings;

i. There is no labour market.
ii. The household may keep output for self consumption or sell a part of output in the market.
iii. All households have flexible access to land for cultivation.
iv. There is a social norm for minimum acceptable consumption level.

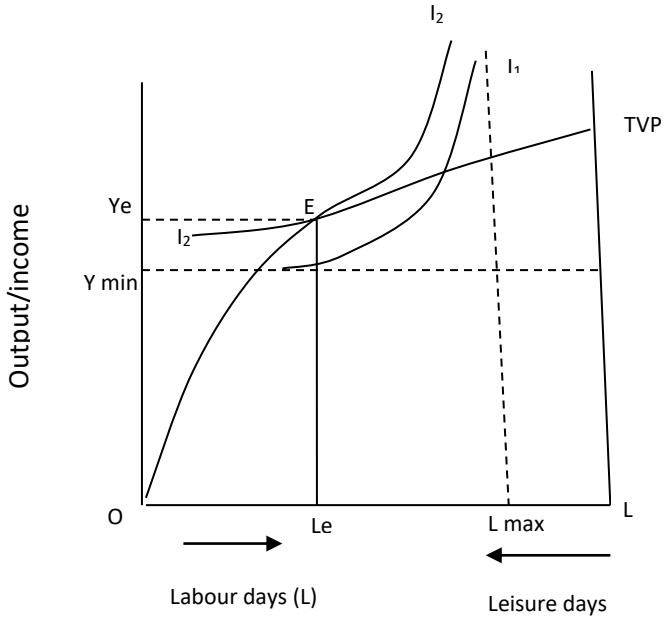
Given these assumptions, Chayanov model focuses on the subjective decision made by the household with regard to the allocation of family labour to farm work to as to fulfill consumption needs of the family. And subjective decision involves a trade-off between the drudgery of farm work and the income required to meet the consumption needs of the household. It implies that the household has two objectives which contrast with each other. First is, an income objective which requires farm work and second is, Leisure or work

avoidance objective which conflicts the first objective. However, the main objective of the household is to maximize utility.

The trade-off between the two objectives is influenced by the demographic structure of the household. The demographic structure is given by the size and composition of peasant household. It is indicated by the ratio of consumers to workers in the household, i.e. C/W ratio. Higher the C/W ratio, more the peasant household has to commit labour on farm work and vice-versa.

The central elements of Chayanov's theory of peasant household are depicted in the figure below.

The gross output is measured on the vertical axis and the total labour time available to the household is measured along the horizontal axis. The total time can be allocated either to farm work or to Leisure activities. The numbers of days devoted to farm work is measured from left to right, OL and the number of days used for Leisure is measured from right to lets, LO.



The production side is given by the production function:

It shows that total income of the family is a function of only market price of output and labour.

The consumption side is represented by a set of indifference curve I_1, I_2, which show the amount to utilize given by alternative combination of the utility function is given as;

U = f (Y, H)

It shows that utility of the peasant household is a function of income (Y) and Leisure (L).

The stage of indifference curve gives the amount of income (dy) needed to compensate for the loss of one unit of Leisure (dH). It is the households subjective wage level.

The utility is maximized subject to:

$Y = Py.f(L);\ \ Y \geq Ymin;\ \ L \leq L\,max$

The solution to this problem occurs where the marginal rate of substitution between Leisure for income (subjective wages) equals the marginal value product of labour:

$MU_H/MU_y = dy/dH = MUPL$

This condition is achieved at point E in the figure. The peasant household reaches equilibrium at point E corresponding to which the labour days is Le and income is Ye. At his point, the marginal value product of labour (MVPL) is equal to subjective wage (dy/dH).

In conclusion, the Chayanov model shows how the peasant household tries to maximize the household's utility by allocation family labour in farm work and Leisure. It also explains the factors that influence the decision of the household. The main feature of the model is the demographic structure of the household which influence the allocation of labour to farm work and Leisure. Another feature of the model is flexible access to land and limited engagement in the labour market. However, the model has not been found much useful for policy purpose due to ambiguity about the impact of changes in production function on household decisions.

8.8 Barnum–Squire Farm Household Model

Howard Barnum and Lyn Squire develop and apply a model of a farm household in 1979. This model is different from Chayanov model to a great extent and it provides a framework for predicting the about the responses of the farm household to changes in domestic and market variables. Domestic variables include family size and its composition. Market variables include prices of output and inputs, wage rates etc.

The model is based on the following assumptions.

i. There is a labour where farm households can hire in and hire out labour at a given wage rate.
ii. Land is fixed in supply
iii. Leisure and home activity (productions of Z goods are treated as single item in utility function.
iv. There is no uncertainty and risk.
v. The household has a choice between own consumption of output © and sale of output in order to purchase manufacture goods (M).

Given these assumptions, the model can be explained as follows:

There are three items in the utility function; time for Leisure and production of Z-goods (T_z), consumption of farm output (C) and manufactured goods (M). Thus, the utility function is:

$U= f(T_Z, C, M)$

The choice between these items is influenced by the demographic structure of the household such as size and composition.

The production function is given as

$Q = f(N, L, V)$

Where N is land under cultivation, L is labour and V is other variable inputs used in production. The household maximizes utility subject to three constraints:

i. time constraint
ii. income constraint
iii. production function

The time constraint is represented as:

$T = T_Z + T_F + T_W$

Where, T_Z is the time used for Leisure and home activity, T_F is the time denoted to farm work and T_W is the time of hire in or hired out labour. If $T_w > 0$, labour is hired in and if $T_w < 0$, then it indicates that labour is hired out.

$T_z+T_F=G$

Here G represents households own time. The income constraint can be represented as follows:

$P(Q\text{-}C) \pm WT_W - v.V = m.M$

Where P is the market price of farm output, $(Q - C)$ indicates quantity sold, W is the market wage rate and V and m are the prices of variable inputs and manufactured goods respectively.

The equilibrium conditions for this model are as follows:

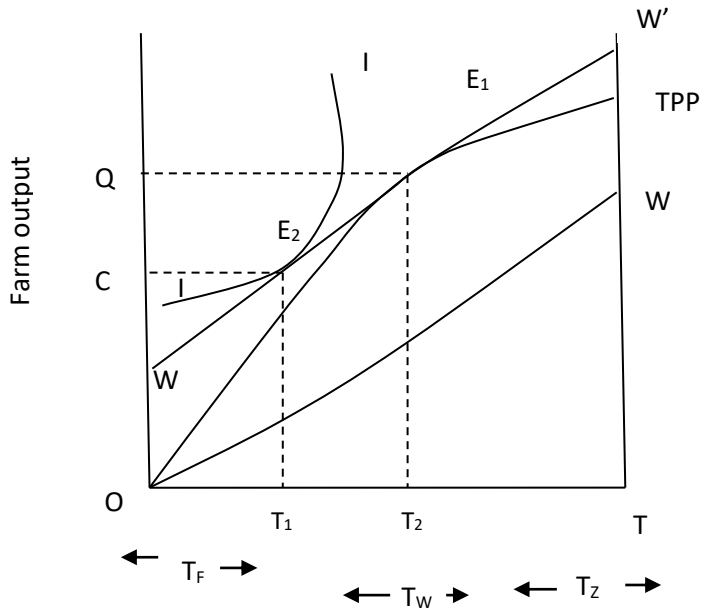
a) The marginal value product of labour (M_VP_L) should be equal to the wage rate (W) and marginal product of other variable inputs (M_VP_V) should be equal to their average prices (.V).
b) The marginal rate of substitution between each pair of items in the utility function should be equal to the price ratios between them.

Since, there exists three items in the utility function and three resources in the production, the model cannot be depicted in a single graph. However, the basic logic of the model can be represented by making simplified assumption that –

a) These is only two items in the utilizing function, T_Z and C, the equilibrium condition will be, MRS T_Z, C = W/P.
b) The production function has only a single variable input, labour. The equilibrium condition is MPP + W/P.
c) Labour is hired in rather that hired out by the house hold.

The model is illustrated in the figure as below

In the figure, total time is measured along the horizontal axis. The time is divided between the farm works of family members. T_F time of hired in labour, T_W; and time of household members denoted to Leisure and home activity, T_Z. There is an opportunity cost of time which is given by the real wage W/P, where W is the money wage and P is the price of farm output. The slop of the line OW gives the rise is the total cost of labour with increase in its use. The point W represents the total implicit cost of all units of time.



In the figure TPP is the production function and I_1 is the indifference curve. The shifted wage line WW' represents the relative wage cost of farm production. The farm household reaches equilibrium in production at E_1 at which marginal product of labour is equal to relative wage W/P. The equilibrium in consumption is reached at point E_2 where marginal rate of substitution between C and T_Z is equal to W/P. The equilibrium level of output and consumption are Q and C and (Q-C) is the farm output that is marketed. The revenue from the sale of output is sufficient to pay wages to hired labour.

Even in a simplified form the model has a lot of productive power concerning the impact of changes in the domestic and market variables on the household's decision. For example, a rise in market wage rate will increase the price ratio, W/P and this herds to a full in output, a rise in farm work by the household and a fall in use of hired labour.

Thus, the Barnum-Squire model has considerable predictive power regarding the responses of farm household to changes in market and domestic variables. The analytical power of the model resides in its capacity to pursue the impact of joint production and consumption decisions by the household into the larger economic system. In other words, the model provides the basis for a general equilibrium analysis of the peasant economy in addition to the partial equilibrium of the various components in the individual household.

8.9 The Low's Model of farm household

Allan Low developed a model of farm household in 1986. His model differs in some respects from the Barnum-Squire model. The model is based on the agricultural production in African countries bordering South Africa. In those countries the main feature of economic life is the existence of a well-developed market for labour.

The model is based on the following assumptions.

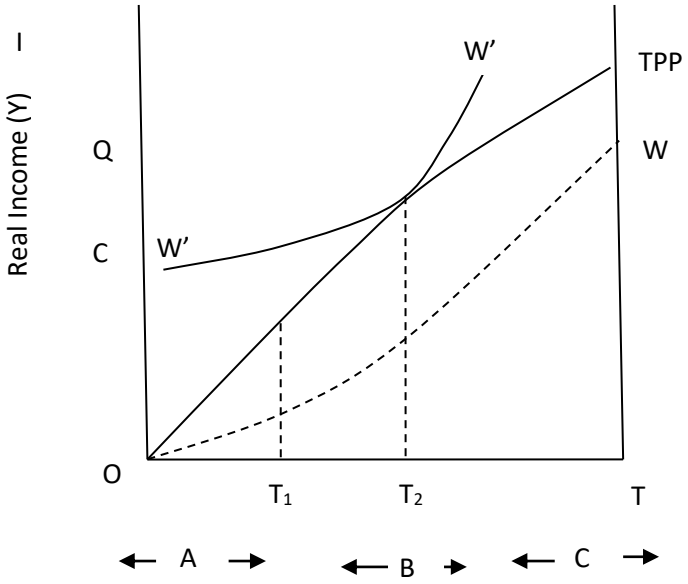
1. There exists a labour market where the wage rate is different for the different categories of labour, especially between men and women.
2. There is an indigenous land tenure system which permits feasible access to land for farm household.
3. The price of farm output differs from the retail price of food in the market.
4. There exist a large number of food deficit farm households with hiring out of family labour.

The first assumption implies that the different members of the households say, A, B and C have different earning capacity in the labour market. In other words, some members have a greater advantage in wage work than the others. The second assumption indicates that the land input can be increased along with labour input. This will defer the outlet of diminishing returns. Hence, low assumes that the marginal physical product (MPP_L) only labour remains constant over the relevant range of economic analysis.

The third assumption implies that the price of farm output is different from the price at which the food can be bought from the market. The forth assumption implies that there exist, a large number of food-deficit farm household. The amount of labour commit to farm work for such house-hold depends not only on the price of farm output but on the real wage.

The low's model of farm household can be illustrated as below

In the figure, the real income is measured on the vertical axis and time is measure on horizontal axis. For illustrative purpose, it is assumed that the house hold consists of only three members of working age. The labour times of the members are given by the gaps A, B and C along the horizontal axis. Each member is assumed to have the same productivity in the farm production, but they command different wage rates in the labour market. This shown by the line OW, the slope of which gives the opportunity cast of labour time of each member. The line WW is the corresponding line of OW which is the parallel opportunity cast of labour time.



The total product curve (TPP) is linear indicating the constant marginal product of labour. The line WW touches the TPP curve at point E which is the equilibrium point. At this point marginal product of labour (MP_L) is equal to the price ratio (W/P). The point E is the profit maximizing level of labour input use for the household because at this point the gap between TPP and OW is the highest.

The implication of the model is that only those members whose real opportunity cost of time, W/P, is lower than their MPP_C will engage in the farm work. Thus, members A & B whose opportunity cost of time is higher than the MPP_L on farm should engage in off-farms work in order maximize house hold income. In the figure, if the slope of the real wage line (W/P) > MPP then that member should engage in off farm wage work and those members whose W/P < MPP, they should engage in subsistence production.

Low's model if in the signified form explains the essential features of peasant economy. The model shows the impact of a fall in retail prices of food or a rise in wage rates on the division of labour within the household. If the retail price of food falls, wage rate remaining constant, the real wage will increase and other members whose opportunity cost of farm work becomes higher will also join off farm work. Those members whose command higher wage rate in the labour market are usually the able bodied members of the household. Hence, the subsistence production is carried out by the women, children and old parent. The

model provides a plausible explanation of agricultural stagnation in the region bordering South Africa.

8.10 Let Us Sum up

This unit discussed the various theories f agricultural development. The Lewis theory focuses on the process of development of a labour surplus country through the transfer of surplus labour from the traditional agricultural sector to modern industrial sector. The Jorgenson model also shows how the transfer of labour from traditional sector to modern sector promotes development in a dual economy. However, the model calls of generating agricultural surplus for labour transfer the Schultz and Mellor's theories suggests various ways and means to transform traditional agriculture. Boserup's theory explains the various phases of agricultural development. The farm household models describe the economic behavior of peasant farm household.

8.11 Key terms:

Subsistence economy: It refers to an economy which relies on natural resources to provide basic needs and self-consumption only.

Capital accumulation: It refers to the increase in assets and capital stock through investment of profits.

Technical Progress: It is the change in technology which leads to shift to production function. It is an economic measure of innovation.

Perfect allocation: It is the point of allocation of resources at which marginal cost of each input is equal to its marginal product.

8.12 Questions

1. Discuss the Lewis theory of development of a labour surplus economy.
2. Explain the Jorgenson's model of development of a dual economy.
3. Examine the Schultzian theory of agricultural transformation.
4. Discuss the Mellor's theory of agricultural development.
5. Explain the Boserup's theory of agricultural development.
6. Analyse the Chayanov's farm household model.
7. Illustrate Barnum-Squire farm household model.
8. Evaluate Low's farm household model.

8.13 Further/Suggested Readings

Soni, R N, *Leading issues in Agricultural Economics*, Vishal Publishing Co.

Ellis, Frank, *Peasant Economics*, Farm Household and Agrarian Development, Prentice Hall.

Basu, K; *Analytical Developed Economy*, Oxford University Press.

UNIT – IX
INSTITUTIONS AND AGRICULTURE

Structure

9.1 Introduction

Agriculture is an important economic activity. It plays a pivotal role in economic development of a country. It contributes to the income and provides employment to a large number of people. Therefore, agriculture development is important to improve the standard of living of a vast majority of people who are engaged in it for their livelihood. However, agriculture in most of the developing countries is backward and is characterised by low productivity. Among the various factors, institutional factor has been considered as one of the obstacles to growth of agriculture in developing countries. This unit contains discussion on the effect of institution on agriculture development.

9.2 Objectives

The objective of this unit is to impart the knowledge about the rural credit market and to understand the various theories and model of rural credit and impact of share tenancy system.

9.3 Land Tenure System

Land Tenure System is an institutional arrangement which governs the ownership of land. There are various ways in which agricultural land owners can organize production. These are as follows:

a) **Family Farm**: In this type of farm production farmers depend entirely on their family labour for the required labour. It is suitable particularly where the joint family system is prevalent and labour costs are high.

b) **Owner-operator**: In this type, the farmers act as capitalist and hires workers at a fixed wage from the labour market to work on their farms to produce various crops. The owner pays wages to labour and make profit by selling output in the market. The owner acts as an entrepreneur and takes up responsibility.

c) **Tenancy**: It is a system in which the landowner leases out plot of land to tenant. The tenant cultivates the land and gives certain proportion of output to landlord as rent.

9.3.1 Types of tenancy:

Tenancy is a form of land tenure system under which the land is owned by the landlord and it is being cultivated by the tenant. There two types of tenancy. These are:

i. Fixed rent tenancy and

ii. Share tenancy

In the fixed rent tenancy, the tenant leases in plot of land from the landlord and pays fixed amount of rent in each period irrespective of the level of output. Thus, in this type of tenancy the tenant because the entire risk of production.

On the other hand, in case of share tenancy, the tenant is required to pay a certain proportion of the output to the landlord as rent for using his land for cultivation. The share of landlord may be determined by the custom and tradition or by the landlord himself. Under the share tenancy, risk of production is also shared between the landlord and the tenant which makes it the mostly wide prevalent system of agrarian contract.

9.4 Tenant-Land owner Model: Marshall and Cheung Models

There are two opposing competitive models of share tenancy. They are –Marshallian model and Cheung model.

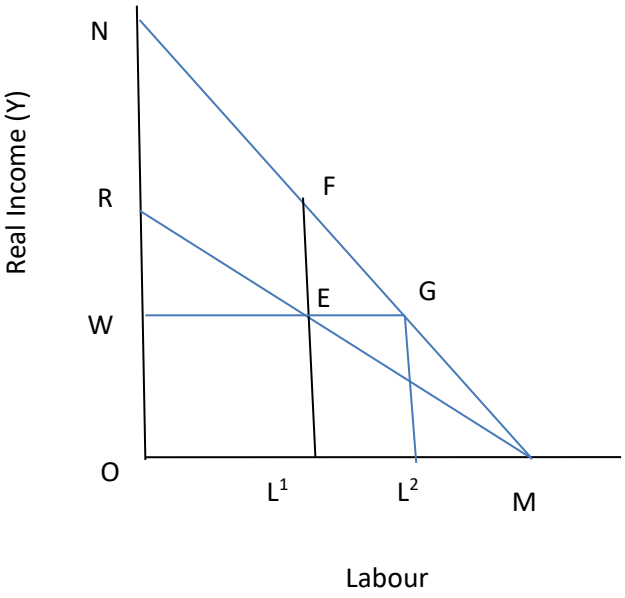
9.4.1 Marshallian model

The Marshallian model of share tenancy views the production behavior from the viewpoint of the tenant. The model was first developed by Alfred Marshall in his book 'Principle of Economics (1890). Marshall's analysis of share tenancy is simple and lucid. His model is based on the following assumptions.

i. The tenant is a profit maximizer.
ii. The tenant is not allowed to lease in any more land from others.
iii. Labour is the only factor of production
iv. The tenant is free to choose the level of inputs to be used in production.
v. The rental share of output is fixed in advance.
vi. The opportunity cost of labour is fixed at W wage rate.

Given these assumptions, the model can be explained as follows:

Assuming that a landlord gives a plot of land to a tenant for cultivation. The tenant must give the landlord fraction r of the total output every year.



In the figure NM shows the marginal product curve of labour and RM sow the marginal learning curve of the tenant. The height of R M at each point is $(1– r)^{th}$ the height of NM curve. The RM curve shows the additional amount the tenant earns with use of additional unit of labour. The opportunity cost of labour is fixed at W wage rate and there exists a market for labour where the tenant can sell his labour. The tenant will use labour up to OL^1 units at which wage rate is equal to his marginal earnings. The equilibrium is reached at point E at which wage rate (W) is equal to tenant's marginal earnings EL^1. At this equilibrium point, the tenant's income will be $OREL^1$ and the landlord will get a rent of NREF amount. The equilibrium use of labour by the tenant is OL^1.

If the tenant had sold OL labour in the labour market, then he would have earned wage income of WEL^1O which is clearly less than $OREL^1$. Thus, the tenant's met income is given by the area REW. So, as long as this net income is positive, it is worthwhile for the tenant to be a share tenant.

In this model, it is found that the use of labour as well as the level of output is below the optional level. So, Marshall argued that the share tenancy is the most inefficient form of agrarian contract. It lends to sub-optimal use of inputs and lower level of output.

9.4.2 Cheung Model

N. S Cheung criticized the Marshallian model of share tenancy and developed a model in 1968. Cheung argued that in the Marshallian model the net income of the tenant is positive to as long as the net income is positive, there will be a large number of people who would be willing to be a tenant. Hence, the landlord can always extract something more from the tenant. So Cheung argued that the equilibrium as explained by Marshall cannot be the equilibrium point.

Cheung model of share tenancy is based on the following assumptions:

1. The landlord is a profit maximizes and decides the rent share.
2. The landlord can control in the share contract the amount of labour input use and size of land to be cultivated.
3. The wage rate is given
4. The only constraint is that contract must allow tenant to earn at least the same income as could be obtained by working as a wage labourer.

With these conditions satisfied, Cheung showed that the share tenancy become efficient.

Cheung model of share tenancy can be formalize as follows:

Assume that a landlord leases out land to a tenant. The output say, X from the land depends on the amount of labour used, L:

$$X = X(L),\ X'(L),\ \geq\ X''(L) < 0 \qquad \text{--- (1)}$$

Let γ be the share of landlord in the output and $(i-\gamma)$ be the share of tenant in the output. It is assumed that the landlord chooses γ and also specifies the amount of labour input, L. However, the landlord must ensure that the tenant is not worse than he would elsewhere, that is $(1-\gamma)$ X (L) must be at least as much as WL. This is because if the tenant's

income is less than what we can earn elsewhere, the tenant would quit. Therefore, the landlord's problem is –

Max ϒ X (L)

Subject to

(1-ϒ) x (L) = WL --- (2)

Forming the lagrangian, we have

Z = ϒ X(L) – $\partial[WL - (I - \text{ϒ})X\ (L)]$

Now by differentiating Z with respect to ϒ, L and ∂, we get the first order condition for maximization.

$\partial Z/_{\partial \text{ϒ}} = X(L) - \partial\ X\ (L) = 0$

$\partial Z/_{\partial L} = \text{ϒ}\ X'(L) - \partial W + \partial(I - \text{ϒ})X'(L) = 0$

$\partial Z/_{\partial L} = (I - \text{ϒ})X(L) - WL = 0$

These imply that –

$\partial = 1$

$X^1(L) = W$

ϒ = [X(L) –WL]/ X(L)

Since $X^1(L)$ = W, the share tenancy as envisaged by Cheung implies an optional use of labour. Now putting the value of ϒ in the objective function, the landlord's maximization problem can be rewritten as –

Max ϒ X (L)

Putting ϒ = (X (L) –WL)/X (L)

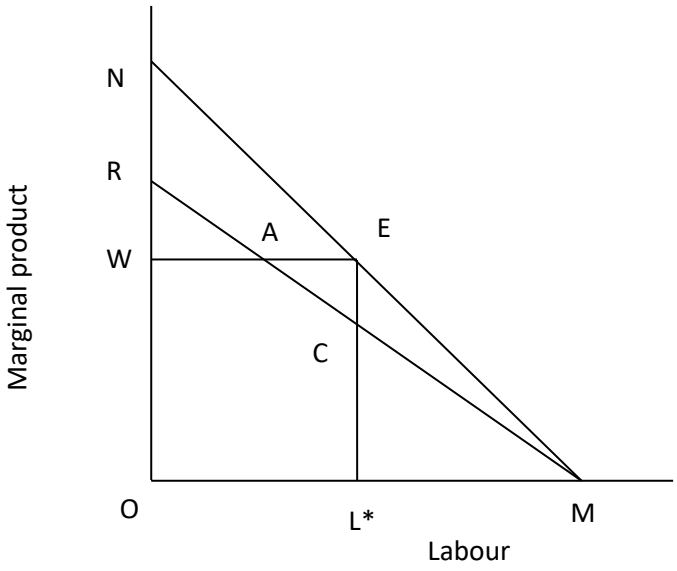
We get

$Max\ \frac{[X(L) - WL]}{X(L)}.X(L)$

Max X (L) – WL

The objective function of the landlord in the Cheung model is similar to that of the capitalist farmer. Thus, a landlord earns the same profit as a capitalist farmer.

The Cheung model can be illustrated as follows:



In the figure, NM is the marginal product curve of labour. The equilibrium is reached it point E at which marginal product of labour is equal to wage rate (W). The equilibrium use of labour will be OL* RM curve gives the marginal earning of the tenant. From equation (2), ϒ must be such that the share of tenant in gross income, that is, (I- ϒ) X (L) equals WL. Hence, RCL*O = WEL*O which implies that RAW = EAC. Therefore, the landlords' income is NECR which may alternatively be represented by NEW. This analysis has an interacting implication.

If the landlord had given the same land out to a tenant on a fixed –rent basis, the maximum rent that could be charged is NEW. Hence, share tenancy of Cheung and fixed rent tenancy are indistinguishable.

9.5 Rural credit market

In the rural areas these are two sources of credit, namely, formal and informal sources. The formal source include-commercial banks, cooperative credit institutions, Regional Rural Banks, agricultural finance corporations, National Bank for Agriculture and Rural Development etc. On the other hand, informal source consists of private money lender, landlords' relatives and friends etc.

The farmers need credit for various purposes and for different duration of time. They need short term credit to meet production and family expenses such as to buy seeds, fertilizers and other inputs. They need credit to support their families when crop fails due to floods or drought. The farmers need medium term credit to purchase tools and implements, livestock's and land improvement. The farmers also need long-term credit for purchase of land, machineries like tractor, harvester construction of houses or bunds etc. It has often been found high interest rates in rural areas of underdeveloped countries. The existence high interest rates have been the source of puzzlement to economists. At the same time, the rates of interest vary from region to region. In one region the farmers get loans at 15 percent and in other regions they have to pay more than 100 percent interest rates on their loan.

This has raised that question as why arbitrage between sectors does not take place which can lead to more homogeneous and lower interest rates in rural areas. But this does not happen and the interest rate continues to persist high to rural areas. This calls for explanation

as to why the interest rate differential continues to persist between rural and urban sectors. In this direction two theories have been advanced which explains the reasons for high rural interest. These theories are discussed as follows:

1. The Lender's Risk Hypothesis: This hypothesis was developed by Tuh Wai, Bottomley and Raj. It states that money lends in the backward regions face a positive risk of default. So, he charges a higher rate of interest to earn positive returns. If the risk of default is taken into account, the effect interest rate will not be higher than that in the formal market. The hypothesis assent that the rate of interest is high not due to monopoly but due to risk of default.

   The hypothesis can be explained as follows: Suppose that a money lender extends a loan of L amount at interest rate is. He expects that an average a fraction of the loan is defaulted. Given this, the lender's expected earnings will be –

   (1+i) (1-q) L-L

   Dividing the above equation by L, we get the effective interest rte ɤ

$$ɤ = \frac{(I+i)(I-1)L-L}{L}$$

$$or, ɤ = \frac{(1+\mathrm{i})(1-\mathrm{q})\mathrm{L}}{\mathrm{L}} - \frac{\mathrm{L}}{\mathrm{L}}$$

$$Or, ɤ = (1+\mathrm{i})(1-\mathrm{q}) - 1$$

$$or, ɤ = 1 + \mathrm{i} - \mathrm{q} - \mathrm{iq} - 1$$

$$Or, ɤ = 1 + \mathrm{i} - \mathrm{q} - \mathrm{iq} - 1$$

or, ɤ = (i-iq) –q

$$\therefore\ ɤ = \mathrm{i}(1-\mathrm{q}) - \mathrm{q}$$

Clearly if q>0, then ɤ< i. But if q=0, indicating no default then, ɤ=I. Thus, given the positive risk of default. The tender charges I rate of interest which is much higher than the formal interest rate. However, his actual return is no higher than the rate of return in the formal sector.

To illustrate this let us consider an example in which q=0.5 and interest rate in urban organized sector is 10 percent. This implies that in equilibrium, ɤ = 0.1. Now putting the values of q and ɤ in the above equation, we get the value of i.

ɤ = i(I-q)-q

or, 0.1 = i(1-0.5) -0.5

or, 0.1 = 0.5i-0.5

or, 0.1+0.5 = 0.5i

or, 0.6 = 0.5i

or, I = 0.6/0.5

∴ i= 1.2 or 120%

It shows that in order sustain an effective rate of interest of 10 percent; the money lender will have to change interest rate 120 percent given the positive risk of default of 50 percent. This is the main conclusion of the lander's risk hypothesis on the prevalence of high interest rate in rural areas.

9.5.1 Criticism

The lenders risk hypothesis can be useful in some situations. But is cannot be accepted a general proposition. The theory suffers from the following drawbacks.

1. It does not pay adequate attention to the personalized nature of rural credit market. The borrowers usually cannot get away without repaying the loans to lender. Therefore, risk of default cannot explain the high rural interest rate.
2. In the rural areas borrowers usually take a loan by pledging the standing crops, land and other valuable assets. The voluntary default is very small. Hence, Saleem in 1987 argued that the lender's risk hypothesis cannot fully explain the high rural interest. To him, high rural interest rates are due to the result of market fragmentation and the monopolistic powers of money lenders.

9.6 Monopolistic credit market

The monopolistic credit market theory for the high rate of interest in rural areas has been developed in the backdrop of inadequately of the lender's risk hypothesis. Bottomley in 1964 observed that the village money lenders exercise monopoly power in the rural credit market. The money lenders enjoy monopoly power due to intimate knowledge that they have about the borrower's circumstances. Hence, the money lenders lend only to those borrowers with whom they have some kind of relation. Therefore, it is very difficult for the competitors from outside enter into a rural money market.

Thus, it is the monopoly power enjoyed by the money lender which keeps the rate of interest high in the rural credit market. The money lender charges higher rate of interest on borrowers to earn maximum net return.

The monopolistic credit market theory on high rural interest rate can be formalized as follows.

Suppose that a borrower can get loans only from one money lender. Let the borrower's loan demand function be –

L= L(i), L'(i) < 0, ----(1)

Where,

L = Loan amount

I = interest rate

Let the inverse function of (1)

be as follows;

i= i(L), i' (L) < 0 --- (2)

This demand function for loan is shown by the line AN in the figure.

Since, there is very low probability of defaulting due to personalized relation between the lender and borrower, the money lender choose L and i so as to maximize his interest earnings. Supposing that the lender has an option of investing his money elsewhere and earning an interest rate of ɤ percent on it.

The Lender's objective function is

maxL.i(L) - L ɤ

The first order condition for maximization is that –

$$\frac{\partial[L.i(L) - L\gamma]}{L\partial} = 0$$

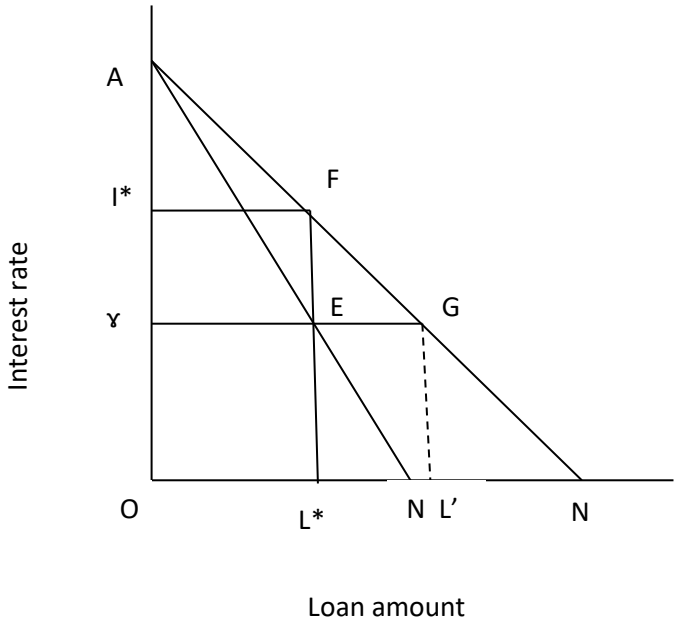
$$or, \frac{\partial L.i(L)}{L\partial} - \frac{\partial L\gamma}{\partial L} = 0$$

$$or, \frac{i(L)\partial L}{\partial L} + \frac{L.\partial i(L)}{\partial L} - \frac{\gamma\partial L}{\partial} = 0$$

$$\therefore \ \gamma = i(L) + \ i'(L)L - - - - - (4)$$

The left hand side (γ) is the marginal cost of giving loans and the right hand side represent the marginal revenue. Hence, it is similar to the condition, MC = MR which is the conditions of equilibrium in a monopolistic market. The equilibrium condition is illustrated in the figure as below.

In the figure, loan amount is measured along the horizontal axis and interest rate along the vertical axis. The line AN is the demand curve for loan and the line AM represents the marginal revenue curve. The money lender has the option of investing the money in the urban credit market at γ represents the opportunity cost of giving loan to borrower in rural credit market. The equilibrium takes place at point E at which marginal cost is equal to marginal revenue. The equilibrium loan amount is L* and interest rate is i*. The money lender earns net profit of FEγi* amount. This amount of profit could be obtained by charging the rate of interest on borrower which is much higher than the urban formal interest rate. This high interest rate in rural credit market is due to the monopoly power exercised by the money lender.



9.6.1 Criticisms

The monopolistic credit market theory has been criticized on two important points.

1. Theory presumes that the borrower always has enough money to repay the borrowed amount. But in reality the borrowers are poor and they are often short of cash to repay the debt. Sometimes the borrowers are forced to repay the loan in terms of land, implements, cattle or even labour service to lenders.

2. The second criticism relates to the monopoly analysis in general. In the equilibrium condition described above. The money lender earns a profit of FERi*. But this is not the maximum profit that monopolist lender can earn the money lender can extract more and could earn a much higher profit of AG$_Y$ by offering the borrower 'all or nothing' contracts.

9.7 Characteristics of semi-feudalism

Semi-feudalism refers to a political and economic system in which the relations of production have more in common with the classical feudalism of the master-serf type than with the industrial capitalism. Feudalism is basically rule by an oligarchy – a group of owners. The feudalism prevailed in the Europe during the centuries. During those periods the economy was based on agriculture. The feudal aristocracy ruled by owning all the land, while the cultivation was done by serfs. If the serfs wanted live, they had to do whatever the land-owning aristocracy dictates them to do. The land owners had the power of life and death over the property less serfs.

Today agriculture is still a primary industry, but only a small fraction of population works in agriculture though the feudalism has gone but even today landlords own huge plot land and act as feudal lords. They enjoy the ownership right ever the land and leaser out land to tenant. The tenant cultivates the land pay a part of output to the landlords as rent. This has come to be known as neo-feudalism or semi feudalism.

The main characteristics of semi-feudalism are as follows:

a) **Sharecropping**: It is an extensively used method in agriculture. It refers to an agrarian system in which the landowner leases out his land to a tenant. The tenant cultivates the land, but the output is shared between the tenant and the landowner. The share is determined by the custom or fixed by the landlord. This system is a very complicated one, as it varies from case to case in terms of whether the tenant supplies any working or fixed capital and how secures the right of the tenant.
b) **Perpetual indebtedness**: The tenants are usually poor and are heavily indebted. A large proportion of tenant's share of output is taken away after the harvest as repayment of past debt with interest. This reduces his actual available balance of

output below his consumption requirement. Hence, he is required to borrow from the landlord to meet his consumption. This perpetuates indebtedness of the tenant.

c) **Consumption loans**: The perpetual indebtedness of the tenant compels him to take consumption loan which is extended to him by the landlord. This lends the whole system the definite character of semi-feudalism. Thus, the tenant is perpetually indebted to the person from whom he leases in the land and this reduces him virtually to the state of a traditional serf. He is more or less tied to the particular landlord and cannot move out until he settles the debt.

d) **Inaccessibility to the market**: The tenant has no access to banks to borrow funds to meet his requirement. This is because he is usually not credit worthy in any bank as he has no asset to show as collateral. Thus, his landlord is the only source of borrowing who lends him against the future harvest but charges higher rate of interest.

The tenant also does not usually have access to the commodity market as a seller of this product. He cannot take the advantage of fluctuation in price as he has to borrow when the prices, are high and sell when the prices are low. Thus, he is the victim of price fluctuations.

9.8 Stagnation under semi-feudalism- Bhaduri's model

The theory of stagnation and agricultural backwardness under semi-feudalism was put forwarded by Amit Bhaduri in 1973. The model contracts the view points of other economists like Marshall by treating the landlords the one who decides whether to innovate or not. In, his model, Bhaduri states that in a semi-feudal economy it is usually not in the interest of landlord to undertake innovation. This is because the innovation will make the tenant well off by increasing his income and he will not long need consumption loan from the landlord. This will reduce landlord's interest income. In a semi-feudal economy, landlords has two sources of income ; (a) property income which is the rental share of total output and; (b) Usurious income which is the income obtained by lending money to the tenant at high interest rate. With innovation, the total output and hence, tenant's income will go up and his need for consumption loans goes down. This will hurt landlords' interest. Therefore, the landlord is usually not interested to undertake innovation.

The model is based on the following assumptions.

1. Paddy is the only commodity consumed by the tenants. All the relevant variables are measured in physical units of paddy.
2. Consumption loans in paddy taken by the tenant to survive from harvest to harvest are the only form of loan.
3. Risk and uncertainly have been ruled out.
4. The area operated per tenant is assumed to be fixed
5. It is assumed that initially the paddy balance available to the tenant after the repayment of the past debt with interest is lower than the minimum consumption level and the tenant is caught in a stationary state of perpetual indebtedness.
6. Finally, the length of production cycle of paddy is treated as the unit of time.

Given these assumptions, the model is formally explained as follows. For simplicity let us assume that a tenant produce unit of paddy each year. Let α be the share of tenant and (1- α) be the rental share of landlord in the total output. It is assumed that the X is technologically given and α *is given by the custom.*

Let bt be the amount borrowed by the tenant in year t and Let Ct be amount consumed by the tenant. The interest rate is I and it is assumed that the tenant does not save. Given these, the model can be presented as ;

bt = Ct-(αX-(I+i)bt-1--- (2)

The rural economy is assumed to be in a stationary state equilibrium. In a stationary equilibrium, the values of the variables remain unchanged from one year to another. Hence, in a stationary state.

Ct = C and bt= b for all time (t) substituting the stationary values in (1), we have

b = C – [αx – (I+i) b) b

or, b= C-[αx-b-ib]

or, b= C-$\alpha x - b - ib$

or, ib = $\alpha x - c$

$\therefore b = \frac{\alpha}{i}x - \frac{c}{i}$----- (2)

Let $\bar{x}$ be the yearly output, which remains unchanged till the technology changes. Assuming that the consumption is fixed at the minimum subsistence level $\bar{c}$.Denoting the yearly borrowing by $\hat{b}$ we can rewrite equation (2) as –

$$\hat{b} = \frac{\alpha}{i}\bar{x}\frac{\bar{c}}{i} - - - - - (3)$$

This equation shows the most interesting feature of the model, that is perpetual indebtedness of tenant. The equation shows a debt trap from which the tenant, once caught, cannot get out.

The situation of indebtedness can be explained with the help of an example as follows;

Let $\bar{x}$= 100, $\alpha = {}^{1}/_{2}$, $\bar{c}$=30 and i=1 (i.e. 100 percent)

If $\hat{b}$ = 20, then consider any year in which the harvest is 100 units of paddy. Afdter paying the rent, i.e. haft of the output, the tenant has 50 units. From which repays his past debt. Since $\hat{b}$=20, the tenant's debt is 20. Given 100 percent interest rate, he must pay his landlord 40 units of paddy. Thus, his debt, he is left with only 10 units of paddy [50-40 =10 units]. But he needs 30 units of paddy to his subsistence. Now, again he has to borrow 20 units of paddy. In the next too, same situation goes on and the cycle continues until the innovation takes place to can augment the output.

In the above example, the landlord's yearly income is 70 units of paddy (50 units rental income and 20 units as interest income].

The above situation is described as a 'debt trap' in which the tenant is caught. The only way to come out of this trap is the innovation which can increase the output.

9.8.1 Criticism of Bhaduri's model

The model has been criticized on the following grounds:

The model has realistically explained the situation of indebtedness. But the explanation of the persistence of indebtedness is not adequate. Newbery in 1975 observed that in this model the landlord does not excesses any power to maintain the trap. Hence, it is very easy for the tenant to get out of the trap. A good year with a slightly better than usual harvest could help the tenant to get free from the trap.

Even if the harvest is the same, the tenant can free himself through a simple adjustment. In the model the tenant borrows 20 units each year. Now if the tenant rational and farsighted he can borrow 5 units less than usual in one year i.e. he borrows 15 units. In the next year, his paddy balance is 20 units. Thus, to consume 30 units, he needs to borrow only 10 units. In the following year, his paddy balance becomes 30 units and he needs no loan. Thus he is free from the trap.

9.9 Let Us Sum Up

This unit discussed the tenant land owner model developed by Marshall and Cheung. It also discussed the rural credit market and explained the theories being existence of high interest rate in rural credit market. There is also a discussion on the characteristics of a semi-feudalism and stagnation under semi-feudalism in the light of Bhaduri's model.

9.10 Key terms

Tenancy: It is an agrarian system in the land which belongs to the landlords is being cultivated by the tenant and the rent is paid as a share in output.

Stationary state: It is a situation in which the value of the variables remains the same.

Stagnation: It denotes a situation when the level of income of an economy remains unchanged.

Feudalism: It is a system in which the land belongs to a group of aristocrats and serfs are engaged to cultivate the land.

Opportunity cost: It is the earnings of a factor in its next best alternative use.

9.11 Questions

1. What is tenancy? What are its types?
2. Explain the Marshall-Cheung models of share tenancy.
3. Discuss lender's risk hypothesis.
4. Explain the monopolistic market theory on rural credit.
5. Explain the characteristics of semi-feudalism.
6. Critically analyse Bhaduri's model of semi-feudal economy.

9.12 Further/Suggested readings

Basu, K., *Analytical less Developed Economy*, Oxford University press.
Ray, D., *Development Economics*, Oxford University Press.
Bardhan, P.K., *Land, Labour and Rural Poverty*, Oxford University Press.

UNIT- X

ISSUES IN AGRICULTURAL DEVELOPMENT IN INDIA

Structure:

10.14 Further Reading/ Suggested Readings

10.0 Introduction

While agriculture's share in India's economy has progressively declined to less than 15% due to the high growth rates of the industrial and services sectors, the sector's importance in India's economic and social fabric goes well beyond this indicator. First, nearly three-quarters of India's families depend on rural incomes. Second, the majority of India's poor (some 770 million people or about 70 percent) are found in rural areas. And third, India's food security depends on producing cereal crops, as well as increasing its production of fruits, vegetables and milk to meet the demands of a growing population with rising incomes. To do so, a productive, competitive, diversified and sustainable agricultural sector will need to emerge at an accelerated pace. India is a global agricultural powerhouse. It is the world's largest producer of milk, pulses, and spices, and has the world's largest cattle herd (buffaloes), as well as the largest area under wheat, rice and cotton. It is the second largest producer of rice, wheat, cotton, sugarcane, farmed fish, sheep & goat meat, fruit, vegetables and tea.

10.1 Objectives

To understand the Agricultural system in India

To study Problems of diffusion of new technology

To analyze the reason behind the limited spread of green revolution

To study the Mode of production debate in India: Rudra, Patnaik and Chattopadhya's views only

To study about Inter-sectoral terms of trade

To study the concept of Food security

To understand the relationship between the state and agriculture

To study about WTO and Indian agriculture.

10.2 Agricultural System in India

The Indian farmer had discovered and begun farming many spices and sugarcane more than 2500 years ago. Did you know that our country is the 2nd largest producer of agricultural products in the world? In fact, agriculture contributes as much as 6.1% (as of 2017) to our Gross Domestic Product (GDP). Let us find out about the different methods adopted by an Indian farmer and how it helps him grow all the variety of crops that we consume and export.

10.2.1 Agricultural Methods of the Indian Farmer

Farming is one of the oldest economic activities in our country. Different regions have different methods of farming. However, all these methods have significantly evolved over the years with changes in weather and climatic conditions, technological innovations and socio-cultural practices. Farming methods prevalent in India can be classified as follows

10.2.2 Primitive Subsistence Farming

This is a primitive farming method and farmers still practice it in some parts of the country. While this type of subsistence farming is typically done on small areas of land, it also uses indigenous tools like a hoe, Dao, digging sticks, etc. Usually, a family or the local communities of Indian farmers are engaged in this farming method that uses the output for their own consumption. This is the most natural method, where the growth of crops dependent on the rain, heat, fertility of the soil and other environmental conditions.

The key to this farming technique is the 'slash and burn' method. In this practice, once the crops are grown and harvested, the farmers burn the land. They then move to a clear patch of land for a new batch of cultivation. As a result, the land gains back its fertility, naturally. Because no fertilizers are used for cultivation, the primitive subsistence method yields good quality crops and also retains the properties of the soil.

Different names of this farming method are:

- 'Jhumming' in the North-Eastern states of Assam, Meghalaya, Mizoram, Nagaland, Arunachal Pradesh, Manipur, Bastar district of Chattisgarh, and in the Andaman and Nicobar Islands.
- 'Bewar' or 'Dahiya' in Madhya Pradesh
- 'Podu' or 'Penda' in Andhra Pradesh,
- 'Pama Dabi' or 'Koman' or Bringa' in Orissa
- 'Kumari' in the Western Ghats
- 'Valre' or 'Waltre' in South-eastern Rajasthan
- 'Kuruwa' in Jharkhand and
- 'Khil' in the Himalayan region

Crops grown: Some of the crops grown through the primitive method are bananas, cassava, rice, maize, and millet.

10.2.3 Intensive Subsistence Farming

This is yet another variation of subsistence farming. In this method, cultivation happens across larger areas of land and thus, it is labor-intensive. Also, to get a high quantity of produce chemical fertilizers and different irrigation methods are used to yield more crops.

Crops grown: Intensive subsistence farming yields two types of crops- wet and dry. While the wet crops include paddy, the dry ones vary from wheat, pulses, maize, millets, to sorghum, soya-beans, tubers, and vegetables.

Intensive Agriculture Development program (IADP) was the first major experiment of Indian government in the field of agriculture and it was also known as a "package programme" as it was based upon the package approach. The programme was launched in 1961 after the Community Development Programme lost sheen. The core philosophy was to provide loan for seeds and fertilizers to farmers. Intensive Agriculture Development program was started with the assistance of Ford Foundation. The IADP was expanded and later a new Intensive Agriculture Area programme (IAAP) was launched to develop special harvest in agriculture area.

10.2.4 Dry Farming

Dry farming or dry-land farming may be defined as a practice of growing crops without irrigation in areas which receive an annual rainfall of 750 mm – 500 mm or even less. Dry land agriculture is subject to high variability in areas sown, yields and output. These variations are the results of aberrations in weather conditions, especially rainfall.

10.2.5 Mixed and Multiple Farming

Mixed farming is referred to cultivation of crops and raising of animals simultaneously. The multiple farming is used to denote the practice of growing two or more crops together. In such case a number of crops having varying maturing periods are sown at the same time. This practice is followed is areas having good rainfall or facilities of irrigation.

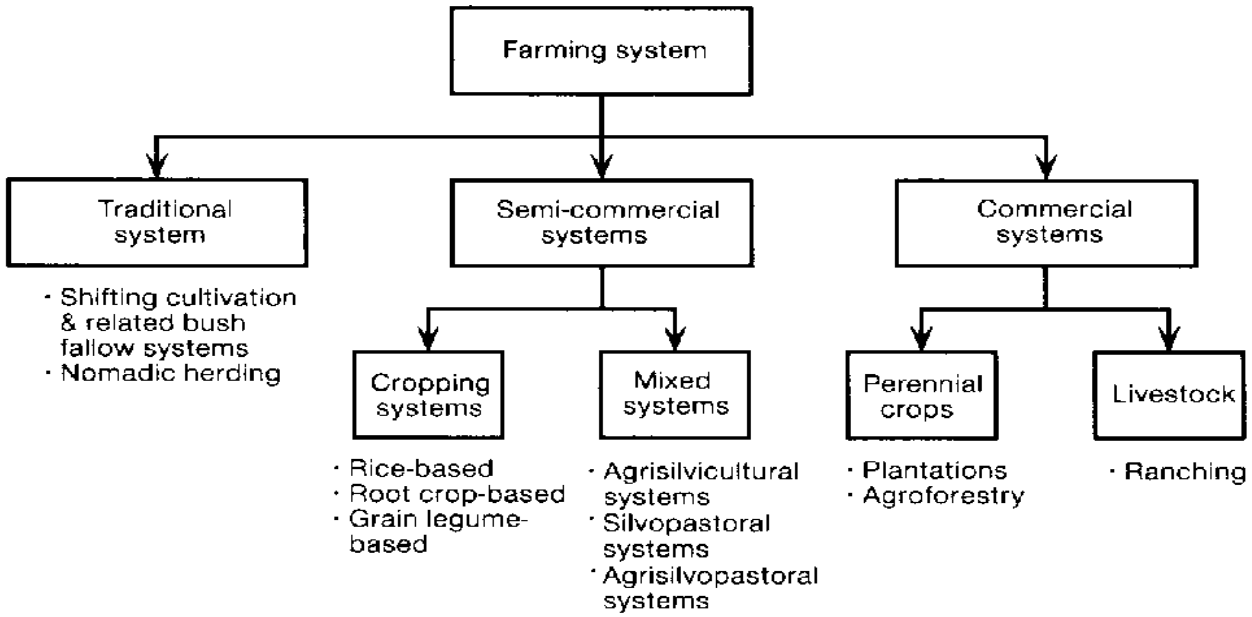
10.2.6 Terrace Farming

The hill and mountain slopes are cut to form terraces and the land is used in the same way as in permanent agriculture. Since the availability of flat land is limited terraces are made to provide small patch of level land. Soil erosion is also checked due to terrace formation on hill slopes.

10.2.7 Commercial Farming

This type of farming is what contributes to the country's economy with huge volumes of yield. In fact, the crops grown commercially in India are used as an export item across the world. In this farming method, the Indian farmer uses a high amount of fertilizers, pesticides, and insecticides to enhance and maintain the growth of the crops. Depending on the crop best suited to the respective weather and soil, commercial farming in India varies across different regions. For example, Haryana, Punjab and West Bengal grow rice commercially, while it is a subsistence crop in Orissa. Major crops grown commercially in India are wheat, pulses, millets, maize and other grains, vegetables, and fruits. Another method of commercial farming is 'plantation'. Plantation farming is a blend of agriculture and industry, practiced across a vast area of land. It is a labor-intensive farming method that also uses the latest technological support for sustaining, cultivating and yielding. The produce yielded from plantations is treated as raw materials to be subsequently used in their respective industries.

Crops grown: Some of the significantly grown crops in plantation farming are tea, coffee, rubber, sugarcane, banana, coconuts, etc



Check your Progress/ Self Assessment Questions

What's the rank of India in the production of agricultural products?

What are the names of indigenous tools used in primitive subsistence farming?

10.3 Problems of Diffusion of New Technology

The contribution of new technology to economic growth can only be realized when and if the new technology is widely diffused and used. Diffusion itself results from a series of individual decisions to begin using the new technology, decisions which are often the result

of a comparison of the uncertain benefits of the new invention with the uncertain costs of adopting it. The diffusion of innovations has been studied from a number of different perspectives: historical, sociological, and economic (including business strategy and marketing), and network theoretical. The choice of approach is often dictated by the use to which the results will be put, but there is no doubt that insights from one perspective can inform the research in another discipline.

10.3.1 Diffusion

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication, in that the messages are concerned with new ideas. It is this 'newness' of the idea in the message content of communication that gives diffusion of special character. The diffusion of innovations is essentially a social process in which subjectively perceived information about a new idea is communicated.

10.3.2 Adoption

A diffusion of innovation with in a social system takes place through its adoption by individual or groups. Adoption is a decision to make full use of an innovation as the best course of action available.

10.3.3 Diffusion of Innovations

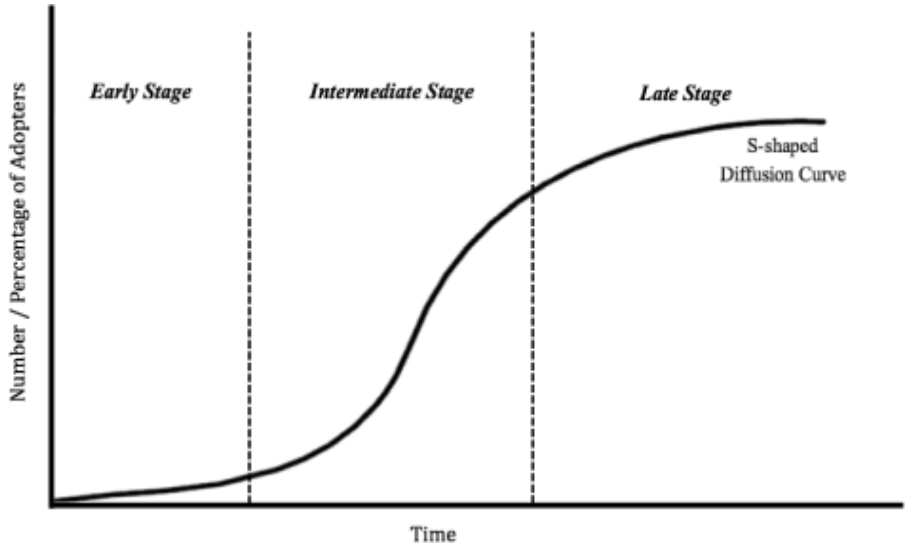
Diffusion of innovations refers to the spread of those innovations through a population, and is simply the result of a host of individual adoption decisions.

If individual adoption decisions are, to an extent, predictable, then the larger diffusion process is also predictable. It follows a pattern, and that element of predictability has substantial implications.

Therefore the diffusion process can be explained with the terms given by Rogers as "the spread of a new idea from its source of invention or creation to its ultimate use of adopters". The diffusion of innovations is essentially a social process in which subjectively perceived information about a new idea is communicated.

The process by which an innovation spreads within a social system is called "diffusion". An innovation, however, diffuse within a social system through its "adoption" by individual and groups.

When an innovation is first introduced in a social system, a small proportion of farmers adopt it. Through interaction with these first adopters and observing the results of its use on their farms, a few more farmers come to know about the innovation and its usefulness, and eventually adopt it.



Over the period of time a large number of farmers become familiar with the innovation through interaction with farmers who have already adopted is reflected in the upward slope of the S-shaped diffusion curve. After the majority of the farmers of the social system have adopted the innovation, only a few hard-core resisters are left who have not yet adopted the practice, and they upward slope comes to an end. The remaining part of the curve now has a more gentle slope until the entire village adopts the innovation. Adoption process is a mental process through which a farmer passes from the first stage of acquiring knowledge of an innovation to taking a decision to adopt or reject the innovation and confirmation of this decision. The process consists of following 5 stages.

A. Knowledge: The farmer comes to know about the technology either through his personal contact with extension personnel, peers (friends and neighbours) or through exposure to radio, television, magazines etc. At this stage, the farmer is exposed to the existence of the technology and he develops an understanding about it.

B. Persuasion: In the persuasion stage, the farmer develops a favourable (positive) or unfavourable (negative) attitude towards the technology. This depends upon the extent of knowledge he acquires, the credibility of the source through which he gets the information on the technology and finally how he interprets the information.

C. Decision: The farmer may opt to choose either to adopt or reject the technology. Normally he/she may not adopt it unless he/she tries it on a small scale himself/herself or he/she observes the trial by other farmers with similar socio-economic status or by extension

personnel who organizes demonstrations on the use of technology. Till this stage, it is a mental exercise, which goes on within an individual.

D. Implementation: In this stage, the farmer implements his decision to adopt or reject the technology. He is more actively engaged in seeking information about the source of availability of the technology, procedure to use it and possible solution for the likely problems he may encounter while using the technology.

E. Confirmation: At this stage the farmer seeks additional information as a reinforcement of the decision already made to confirm whether he has taken the right decision. If the additional information is conflicting with the earlier information, he may possibly alter his decision.

To what extent the farmer adopts a particular innovation could be measured as the ratio of actual adoption and the potentiality of adoption. It is expressed on a percentage.

$$\text{Extent of Adoption} = \frac{\text{No. of Practices Adopted}}{\text{No. of Practices Recommended}} \times 100$$

10.3.4 Reasons for Adoption/ Rejection

The adoption/rejection of any technology or innovation depends to a great extent on the following elements of technology transfer.

A. Perception of the technology by the farmer under his situation as superior and relatively advantageous than the existing technology or the other way.

B. The farmer's knowledge and attitude towards the technology which in turn depends upon his socio-economic status which include his caste, education, family size, type, herd size, income etc.

C. The quality of extension service and number of extension personnel per thousand farm families and or thousand animals.

D. The extent to which the requisite infrastructure facilities and support services are accessible to the farmers.

Check your Progress/ Self Assessment Questions

When the contribution of new technology to economic growth can be realized?

What is the formula to calculate extent of adaptation?

10.4 Limited spread of Green Revolution

10.4.1 Green Revolution: The dramatic transformation in agriculture practices that involves the use of new methods of cultivation and inputs refers to as Green Revolution in India. The green revolution consists of technological improvements which were mainly adopted to increase agriculture productivity. The green revolution occurs as a result of adoption of new agriculture strategy during mid 60's by Government of India to achieve self-sufficiency in the food grains production. These changes bring about a substantial increase in agriculture production in a short span of time.

10.4.2 Impact of Green Revolution

The green revolution resulted quantitative and qualitative development in the agriculture in India. The quantitative improvement occurs as a result of steep increase in the production of agriculture output. The qualitative improvement resulted into adoption of modernized technology in the agriculture. The impact of green revolution can be discussed as follows:

A. Spectacular increase in agriculture production: The dependence on food imports is eliminated with the increase in agriculture production. The country becomes self-sufficient in food grains. In fact India was the second largest importer in 1966 and it imported no food grain in subsequent decades except during late 80's and early 90's mainly due to failure of monsoons or untimely rains or floods in different regions. However, it may be noted that in recent years annual growth in the food grain production is losing its momentum.

B. Improvement in productivity: The tremendous increase in agriculture production occurred as a result of improvements in productivity. The productivity was quite low in the pre-green revolution period. The substantial increase in the productivity occurred in wheat and rice in the earlier periods but later on it spread to other crops also.

C. Increase in Employment: Green revolution generated employment opportunities into diverse activities which were created as a result of multiple cropping and mechanization of farming. It helped to stimulate non-farm economy that generated newer employment in various services such as milling, marketing, warehousing etc.

D. Food grain Price Stability: The adoption of new agricultural technology has led to the increased production and marketable surplus of crops especially food grains that have resulted into price stability of food items.

E. Strengthening of forward and backward linkages with industry: The increase in agriculture production has strengthened the forward linkage of agriculture sector with

industry in the sense of supplying inputs to the industry. The backward linkage with the industry has also received a boost as agricultural modernization created larger demand for inputs produced by industry.

10.4.3 Problems with Green Revolution

The new agriculture strategy has resulted into increased productivity and returns for farmers. This has resulted in decline in rural poverty to an extent. However, the revolution resulted into increased income, wide interpersonal and regional inequality and inequitable asset distribution. The major problems associated with green revolution are as follows:

A. Increase in personal inequalities in rural areas: The income inequality between rich and poor increases due to:

- The owners of large farms were the main adopters' of new technology because of their better access to irrigation water, fertilizers, seeds and credit. In other words, given the need for complex agricultural techniques and inputs, the green revolution benefits the large farmers. The small farmers lagged behind the larger farmer as small farmers had to depend upon traditional production method. Since the rich farmers were already better equipped, the green revolution accentuate the income inequalities between rich and poor.
- Green revolution resulted into lower product price and higher input prices which also encouraged landlords to increase rents or force tenants to evict the land.
- The mechanization pushed down the wages of and employment opportunities for unskilled labor in the rural areas thereby further widening the income disparities.

B. Increased Regional disparities: Green revolution spread only in irrigated and high-potential rain fed areas. The villages or regions without the access of sufficient water were left out that widened the regional disparities between adopters and non-adopters. Since, the HYV seeds technically can be applied only in land with assured water supply and availability of other inputs like chemicals, fertilizers etc. The application of the new technology in the dry-land areas is simply ruled out. The states like Punjab, Haryana, Western UP etc. having good irrigation and other infrastructure facilities were able to derive the benefits of green revolution and achieve faster economic development while other states have recorded slow growth in agriculture production.

C. Environmental Damage: Excessive and inappropriate use of fertilizers and pesticides has polluted waterway, killed beneficial insects and wild life. It has caused over-use of soil and rapidly depleted its nutrients. The rampant irrigation practices have led to eventually soil degradation. Groundwater practices have fallen dramatically. Further, heavy dependence on

few major crops has led to loss of biodiversity of farmers. These problems were aggravated due to absence of training to use modern technology and vast illiteracy leading to excessive use of chemicals.

D. Restrictive Crop Coverage: The new agriculture strategy involving use of HYV seeds was initially limited to wheat, maize and bajra. The other major crop i.e. rice responded much later. The progress of developing and application of HYV seeds in other crops especially commercial crops like oilseeds, jute etc has been very slow. In fact, in certain period a decline in the output of commercial crops is witnessed because of diversion of area under commercial crop to food crop production. The basic factor for non-spread of green revolution to many crops was that in the early 1960's the severe shortage in food grains existed and imports were resorted to overcame the shortage. Government initiated green revolution to increase food grain productivity and non-food grain crops were not covered. The substantial rise in one or two food grain crop cannot make big difference in the total agricultural production. Thus new technology contributed insignificantly in raising the overall agricultural production due to limited crop coverage. So it is important that the revolutionary efforts should be made in all major crops.

It can be concluded that green revolution is a major achievement for India which has given it a food-security. It has involved the adaptation of scientific practices in the agriculture to improve its production and productivity. It has provided benefits to poor in the form of lower food prices, increased migration opportunities and greater employment in the rural non-farm economy. However, the inequalities between region and individuals that adopted green revolution and those who failed to adopt has worsened. Further, green revolution has led to many negative environmental impacts. The policy makers and scientists are urged to develop and encourage the new technologies that are environmentally and socially sustainable.

Check your Progress/ Self Assessment Questions

Why the technological improvements in the green revolution were adopted?

How the green revolution generates the employment opportunities?

10.5 Mode of Production Debate in India: Rudra, Patnaik and Chattopadhya's views only

Ashok Rudra (1930–1992) was not only a fine economist but also a great scholar and a "public intellectual" in the best sense of the term. From the mid-1950s onwards, he conducted many pioneering studies of India's economy and society. Rudra's professional writings, based on painstaking research and strong value commitments, often challenged

established theories and conventional wisdom. He was equally creative and fearless in his interventions in public debates. Rudra also wrote prolifically on literary and cultural subjects, and became an eminent Bengali writer, with a distinct style of his own. Few Indian economists achieved this remarkable blend of technique, scholarship and creativity. Rudra's work on agricultural economics drew on the numerous field surveys he conducted in West Bengal and elsewhere. These include Farm Management Studies for the Ministry of Agriculture, a Survey of Agrarian Relations completed in 1975, and village surveys initiated jointly with Pranab Bardhan. Here as in other fields, Rudra often challenged conventional notions. He was particularly critical of the application of neo-classical economic theory to Indian agriculture. In Indian Agricultural Economics: Myths and Realities, he presented a critique of neo-classical theory. One of the central "myths" exposed in this study is the myth of allocative efficiency in Indian agriculture, especially the proposition that product and factor markets are competitive. Rudra also took issue with the alleged inverse relation between farm size and productivity. Aside from "efficiency myths", the book criticised various "inefficiency myths". For instance, Rudra debunked the "myth of semi-feudal inefficiency", attributed to Bhaduri, whereby semi-feudal landowners "have an economic interest in perpetuating the economic misery of the tenants". He also challenged the myth of "tenancy inefficiency", whereby tenant farms perform less well than owner-operated farms. Rudra felt that understanding class relations was crucial to understand historical processes and contemporary realities. He defined class as "a set of individuals who have similar relations with means of production... and who are such that they have no contradictions among themselves, but have contradictions with members of other classes". Based on this definition he argued that there are two classes in rural India: big landowners and agricultural workers (though in some areas there may be a third class, that of "subsistence farmers"). This reading of the class structure in rural India was similar to that suggested by Daniel Thorner and Alice Thorner in 1962.

An economists viewed land inequality as the root cause of agricultural stagnation. In a 1986 paper, Utsa Patnaik, a Professor of Economics at Jawaharlal Nehru University, developed the concept of a rent barrier to the development of capitalist relations in Indian agriculture. Patnaik argued that under the landlord-tenant farming arrangement, all production expenses were borne by the latter because of the competition to secure tenancy. Lack of any investible resources with the tenants adversely affected agricultural productivity. It would take extraordinarily high rates of profits for the landlord to undertake investment in agriculture instead of investing capital in otherwise high-return activities like usury, which

had assured returns, Patnaik argued. As a result, investments in agriculture were lacklustre and the sector suffered.

Paresh Chattopadhyay takes issue of production in India with Patnaik as well as on some other questions. He points out that in Marxism free labour' is conceived in a double sense, viz, the freedom on the one hand of the labourer to sell his labour to any employer and, on the other, in the sense that being deprived of the ownership of the means of production, he is freed to sell nothing but his labour. He therefore argues that, 'If the rural labourers in India did not possess any other commodity but their labour power and if they were not tied to particular employers, in that case they, we submit, fulfill Marx's condition. They might be tied to agriculture in the same way as the indutsrial wage-labourers are 'tied' to industry, but that is immaterial insofar as the rise of capitalism in the countryside is concerned.'

Check your Progress/ Self Assessment Questions

The concept of rent barrier to the development of capitalist relations in Indian agriculture is developed by which economist?

10.6 Inter-sectoral Terms of Trade

The Terms of Trade (ToT) is the relative price of exports in terms of imports and is defined as the ratio of export prices to import prices. It can be interpreted as the amount of imported goods an economy can purchase per unit of export goods. An improvement of a nation's terms of trade benefits that country in the sense that it can buy imports more for any given level of exports. The terms of trade may be influenced by the exchange rate because a rise in the value of a country's currency lowers the domestic prices of its imports but may not directly affect the prices of the commodities it exports.

The Inter-sectoral ToT in an economy is best measured with the help of GDP data by sectors at current and constant prices. From this, the implicit GDP deflators by sectors are computed which show the relative prices that producers face in respective sectors. In analyzing ToT, there are alternative price indices available at the national level, but GDP deflators perform equally well. It is customary to divide the economy into agriculture (including animal husbandry) and the non-agriculture sectors for the purpose of examining inter-sectoral ToT between them over time. We, therefore, compute the GDP deflators and use them to arrive at the agriculture vis-à-vis non-agricultural terms of trade.

Check your Progress/ Self Assessment Questions

What is Terms of Trade (ToT)?

10.7 Food Security

The United Nations (UN) celebrates October 16 as the World Food Day every year, with an aim to spread awareness about eradicating hunger and ensuring food security for all. In this context, we examine the status of food and public distribution in India, and some challenges in ensuring food security for all. In 2017-18, over Rs 1,50,000 crore, or 7.6% of the government's total expenditure has been allocated for providing food subsidy under the Targeted Public Distribution System (TPDS). This allocation is made to the Department of Food and Public Distribution under the Ministry of Consumer Affairs. Food subsidy has been the largest component of the Department's expenditure (94% in 2017-18), and has increased six-fold over the past 10 years. This subsidy is used for the implementation of the National Food Security Act, 2013 (NFSA), which provides subsidised food grains (wheat and rice) to 80 crore people in the country. The NFSA seeks to ensure improved nutritional intake for people in the country. One of the reasons for the six-fold increase in food subsidy is the non-revision of the price at which food grains are given to beneficiaries since 2002. For example, rice is given to families under the Antyodaya Anna Yojana at Rs 3/Kg since 2002, while the cost of providing this has increased from Rs 11/Kg in 2001-02 to Rs 33/Kg in 2017-18.

10.7.1 Provision of food subsidy

TPDS provides food security to people below the poverty line. Over the years, the expenditure on food subsidy has increased, while the ratio of people below poverty line has reduced. A similar trend can also be seen in the proportion of undernourished persons in India, which reduced from 24% in 1990 to 15% in 2014. These trends may indicate that the share of people needing subsidized food has declined.

10.7.2 Nutritional balance: The NFSA guarantees food grains i.e. wheat and rice to beneficiaries, to ensure nutritious food intake. Over the last two decades, the share of cereals or food grains as a percentage of food consumption has reduced from 13% to 8% in the country, whereas that of milk, eggs, fish and meat has increased . This indicates a reduced preference for wheat and rice, and a rise in preference towards other protein rich food items.

10.7.3 Methods of providing food subsidy

Food subsidy is provided majorly using two methods.

A. TPDS assures beneficiaries that they will receive food grains, and insulates them against price volatility. Food grains are delivered through fair price shops in villages, which are easy to access.

However, high leakages have been observed in the system, both during transportation and distribution. These include pilferage and errors of inclusion and exclusion from the beneficiary list. In addition, it has also been argued that the distribution of wheat and rice may cause an imbalance in the nutritional intake as discussed earlier. Beneficiaries have also reported receiving poor quality food grains as part of the system.

B. Cash Transfers seek to increase the choices available with a beneficiary, and provide financial assistance. It has been argued that the costs of DBT may be lesser than TPDS, owing to lesser costs incurred on transport and storage. These transfers may also be undertaken electronically.

However, it has also been argued that cash received as part of DBT may be spent on non-food items. Such a system may also expose beneficiaries to inflation. In this regard, one may also consider the low penetration and access to banking in rural areas. In 2017-18, 52% of the centre's total subsidy expenditure will be on providing food subsidy under TPDS. The NFSA states that the centre and states should introduce schemes for cash transfers to beneficiaries. Other experts have also suggested replacing TPDS with a Direct Benefit Transfer (DBT) system. The central government introduced cash subsidy to TPDS beneficiaries in September 2015. As of March 2016, this was being implemented on a pilot basis in a few union territories. In 2015, a Committee on Restructuring of Food Corporation of India had also recommended introducing Aadhaar to plug leakages in PDS, and indexing it to inflation. The Committee estimated that a switch to DBT would reduce the food subsidy bill of the government by more than Rs 30,000 crore.

10.7.4 Current challenges in PDS

A. Leakages in PDS: Leakages refer to food grains not reaching intended beneficiaries. According to 2011 data, leakages in PDS were estimated to be 46.7%. Leakages may be of three types: (i) pilferage during transportation of food grains, (ii) diversion at fair price shops to non-beneficiaries, and (iii) exclusion of entitled beneficiaries from the list.

In 2016, the Comptroller and Auditor General (CAG) found that states had not completed the process of identifying beneficiaries, and 49% of the beneficiaries were yet to be identified. It also noted that inclusion and exclusion errors had been reported in the beneficiary lists. In February 2017, the Ministry made it mandatory for beneficiaries under NFSA to use Aadhaar

as proof of identification for receiving food grains. Through this, the government aims to remove bogus ration cards, check leakages and ensure better delivery of food grains. As of January 2017, while 100% ration cards had been digitised, the seeding of these cards with Aadhaar was at 73%.

B. Storage: As of 2016-17, the total storage capacity in the country is 788 lakh tonnes, of which 354 lakh tonnes is with the Food Corporation of India and 424 lakh tonnes is with the state agencies. The CAG in its performance audit found that the available storage capacity in states was inadequate for the allocated quantity of food grains. For example, as of October 2015, of the 233 godowns sanctioned for construction in Maharashtra, only 93 had been completed. It also noted that in four of the last five years, the stock of food grains with the centre had been higher than the storage capacity available with Food Corporation of India.

C. Quality of food grains: A survey conducted in 2011 had noted that people complained about receiving poor quality food grain which had to be mixed with other grains to be edible. There have also been complaints about people receiving food grains containing alien substances such as pebbles. Poor quality of food may impact the willingness of people to buy food from fair price shops, and may have an adverse impact on their health. The Ministry has stated that while regular surveillance, monitoring, inspection and random sampling of all food items is under-taken by State Food Safety Officers, separate data for food grains distributed under PDS is unavailable. In the absence of data with regard to quality testing results of food grains supplied under PDS, it may be difficult to ascertain whether these food items meet the prescribed quality and safety standards.

Check your Progress/ Self Assessment Questions

Which day throughout the globe World Food Day is celebrated?

What is TPDS?

10.8 The State and Agriculture

The agriculture sector contributed 51.09 percent to India's GDP in 1950. Since then it has been on a downside and it currently stands at 13.9 percent. However, a change from an agrarian-centric economy to an industry-centric economy is inevitable with the advent of industries. With industries growing at a faster pace than the rate at which trees are being planted, will there be a time when agriculture's productivity dwindles to a null? If yes, is it already here?

Living in a country where the cattle are worshipped as a goddess, about 60 percent of the population was banking on agriculture for their main source of income during the 1950s.

Despite half of the population still continuing with the profession, the returns are low. While urbanization might be cited as a reason, it is hard not to neglect the fact that agriculture is no more a profitable sector. Infrastructure costs have started running high, with its maintenance cost and capital investment only adding on to the farmers' misery. According to an article by *The Hindu*, the average recovery rate of the investments made by Indian farmer is only 30 percent.

Another cause for low productivity is small holdings of land with farmers. By owning a fragmented land, effective irrigation and optimum usage of fertilizers for crops becomes difficult, thus resulting in lower yields. In India, more than two-thirds of the crops lack proper irrigational facilities, albeit India being the second largest irrigated country after China. But improper irrigation can also lead to other problems affecting yield like soil erosion, salinity, etc.

In the wake of agriculture losing its lucrative appeal, budget 2016-17 has proposed to bring 2.85 million hectares under irrigation, Rs 2,87,000 to be donated and 100 percent electrification to all villages by May 2018. The government has also announced a couple of initiatives to resolve the farmers' plight.

Some of the recent developments in the agriculture and allied sector are enumerated below:

A. Launch of *Pradhan Mantri Fasal Bima Yojana*

Farming has become an unreliable sector. Farmers are always unsure of the yield they'll reap, but strive to draw the maximum benefits out of their investments and effort. Often farmers might be at the receiving end, with natural calamities like droughts and floods affecting their yield adversely. To resolve the problem of unpredictable nature of farming and prevent farmer suicides in the country, the Government launched *Pradhan Mantri Fasal Bima Yojana* in early 2016. It's a crop insurance policy with relaxed premium rates on the principal sum insured for farmers. Implemented with a budget of Rs 17,600 crore, this scheme will provide financial support to farmers and cover for their losses. This initiative is expected to go on floors from the next *Kharif* season of farming that is from June 2016.

B. After Green, White, and Golden, it's time for Blue

The Cabinet Committee on Economic Affairs (CCEA) has approved Blue Revolution in India. It's an integrated scheme designed to increase the productivity and profitability from aquaculture and fisheries resources, inclusive of both inland and marine. With a budget of Rs 3,000 crore offered by the government for the next five years, this scheme aims to maintain an annual growth rate of six to eight percent of the agriculture and allied sector.

C. Government to invest Rs 221 crore to improve milk productivity

India boasts of being the largest producer of milk in the world with an annual output of 130 million tonnes. However, with a milk-producing animal population of more than 118 million, the milk yields per animal is very low. To meet the steadily growing demand for milk, the National Dairy Development Board (NDDB) has announced 42 dairy projects, under a budget of 221 crore. These projects shall focus on improving the milk productivity of major milk-producing states like Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu and the likes.

D. Energy-efficient irrigation to be implemented

A report says that in India more than two-thirds of the arable area lacks proper irrigational facilities. Taking note of this, Power Ministery said that the Government is planning on investing Rs 75,000 crore to provide energy-efficient irrigational facilities to farmers, over the next three to four years. Under this scheme, close to 30 million energy-saving pump sets would be given to farmers and this cost would be recovered via savings in the electricity consumed. This would result in about 46 billion kWh of power being saved and creation of 20 lakh jobs.

E. Launch of *Paramparagat Krishi Vikas Yojana*

The government has launched *Paramparagat Krishi Vikas Yojana* in order to address the critical importance of soil and water for improving agricultural production. The government would support and improve the organic farming practices prevalent in India. Following cluster approach mode of farming, at least 50 farmers would form a group having 50 acres of land to implement organic farming. The government aims to cover 10,000 clusters and five lakh hectares of arable land under organic farming within three years. Recently, the government has been active in investing in agricultural infrastructure such as irrigational facilities, mechanized farming, and warehousing. The growing use of genetically modified crops will also improve the sector's contribution to GDP. While all of these initiatives look promising, in what way are they going to affect the current scenario are something interesting to watch out for.

Check your Progress/ Self Assessment Questions

What is *Pradhan Mantri Fasal Bima Yojana?*

What is Blue Revolution?

10.9 WTO and Indian Agriculture

The new GATT arrangement and WTO regime, which incorporated various compromise proposals of Arthur Dunkel and which was finalised at Geneva on 15th

December, 1993, have some serious implications on Indian agriculture. During the run up to the GATT agreement, fears were expressed from various corners that India's interest in agriculture will be adversely affected as a result of the proposed agreement on agricultural issues in Uruguay Round. Apprehensions were raised that the country may be forced to reduce the subsidies available to the farmers, phase out the public distribution system and compulsorily open up to agricultural imports. It was also feared that the traditional rights of farmers to retain and exchange seeds may also be constrained. After making a lot of representation in the last meeting some additional provisions were made into the final agreement. A thorough analysis of this new agreement leads to the conclusion that on the whole the country's interests will not only be protected but India may also expect to benefit as a result of agriculture being included into the fold of GATT. The agreement has stipulated that countries with an aggregate subsidy of more than 10 per cent of the value of agricultural produce will have to reduce them. But the current level of subsidy in India is well below this level and this stipulation will therefore not affect the country. Moreover, it has been clarified from the new GATT agreement that the consumption subsidies for targeted groups of population as under our public distribution system which is primarily targeted for the rural and urban poor are legitimate and, therefore, can continue. Farmers' interest will also be completely protected once the proposed 'sui generis' legislation to protect plant varieties comes into effect. Under the proposed legislation, right of farmers to retain and exchange seeds will not be affected. The central feature of the agreement on agriculture is the reduction in production subsidies paid by developed countries to their farmers and the rolling back of some of the non-tariff barriers which have restricted agricultural trade. These provisions will provide benefit to India as the agricultural exports of the country enjoy a comparative and competitive advantage. Therefore, India's agricultural exports will receive a welcome stimulus, at a time when the incentive structures in the domestic economy are beginning to work to their advantage.

10.9.1 Dunkel Plans and Indian Agriculture

Arthur Dunkel, former Director General of GATT, offered certain definite proposals for the reform of the agricultural sector of various countries. The Dunkel Text has four definite proposals for the agricultural sector, as given below:

A. A basic agreement on modalities of the reform programme;

B. A supplementary agreement on the modalities for specific binding commitments under the reforms programme;

C. A decision on application of sanitary and phycosanitary measures; and

D. A declaration on measures to assist food importing centres.

In respect of support measures to be adopted by the Government for the agricultural sector, the Dunkel plan provided (a) Amber Policies and (b) Green policies. The developing countries normally apply policies in the "Green Box" which includes various government support measures for research, pest control, expansion of infrastructure, environmental protection etc.

These measures are very much required for the development of agriculture in the Third World countries.

The Dunkel plan has thus recognised the importance of developmental needs of the agriculture in the less developed and developing countries of the world. Accordingly, the government expenditure on food security and environmental protection have been kept outside the purview of the Dunkel Plan. Moreover, the Dunkel plan has made provisions for the reduction of agricultural subsidies in developing countries, if the value of subsidies exceeded 10 per cent of the value of their total agricultural produce. Now regarding the conditions of Indian agriculture, it can be observed that the country has achieved self sufficiency in food grains production. But considering its huge potential there is still vast scope to raise the productivity in Indian agriculture. In respect of production of food grain crops, the country is lagging behind OECD countries. India is also lagging behind in respect of achieving growth rate in agriculture as compared to many Third World countries. During the first two decades of green revolution (1968-69 to 1988-89), Indian agriculture recorded an average growth rate of 2.9 per cent as compared to that of 6.3 per cent in China, 4.4 per cent in Pakistan and 4.1 per cent in Thailand.

Thus, there is a need for increasing provision for research, modernisation; extension and expansion of infrastructural facilities for agricultural sector along with provision for subsidies for inputs to small and marginal farmers. But Dunkel proposal presents no threat to Indian agricultural subsidies currently at the rate of 5 per cent of the value of agricultural produce. Thus under the present position, the Dunkel plan does not pose any threat of withdrawal or restraint on present trend of government expenditure on the development of agriculture in India. Moreover, agricultural sector in India needs "Green Box" policy supports. In India presently only 25 per cent of the arable land is under assured irrigation as compared to that of 77 per cent in Pakistan, 48 per cent in China and about 47 per cent in Indonesia. This needs a quick redressal measure from the side of Government. Moreover, under the new GATT arrangement, agricultural exports in India are expected to gain

momentum in near future. Thus, in order to meet the challenges and opportunities open to the agricultural sector the Government should make provision for necessary restructuring measures so that the agricultural exports from India become very much competitive in the international market.

10.9.2 Steps taken to Protect Plant Variety by the Government:

In the wake of new General Agreement on Trade and Tariff (GATT) and more particularly after the formation of WTO, paving the way for both globalization and liberalization, the Government of India has initiated some important steps to quickly bring about legislation on the controversial issue plant variety protection in order to safeguard the interests of Indian farmers regarding the use and availability of seeds.

In India we have about 175 varieties of HYV seeds, out of which 96 varieties are developed by Indian scientists.

The Government has identified five important features of the proposed new legislation:

(a) The farmer can choose the best seed that he likes;

(b) The farmer can save seed from one crop and use it for replanting it in the next crop;

(c) The farmers can sell his surplus seed but not as branded seed in case of protected variety;

(d) The farmer can also become a whole-time seed producer and sell protected seed as a commercial enterprise with the consent of the right holder; and

(e) Our scientists will be free to use all seed varieties, including protected varieties, for experiment and research for development of new varieties.

Thus, the farmer would have the choice of buying the seed of his own choice. He would buy protected seed if it was found profitable to do so. The necessity of bringing this legislation emerged because of a kind of plant variety protection would be in the interest of the country.

Besides, the provision of high quality seeds to farmers was an important part of the government's strategy for the development of agriculture. It is for these reasons that seeds were freely importable even now. The agreement on trade related intellectual property rights (TRIPs) provides the signatory countries with the option to exclude plants and animals from the scope of patentability. As per this agreement, parties shall provide the protection of plant varieties either by patents or by an effective "sui generis" system or by any combination thereof. This provision shall be reviewed four years after the entry into force of this agreement. Thus, it is quite clear that the agreement did not impose any compulsion regarding

patenting of seeds or other propagating material. “Sui generis”—a system of its own unique—implied a system different from other categories of intellectual property protection (such patents) and is in a class by itself.

Although the text of the TRIPs agreement does not refer to any particular international convention in the context of the “sui generis” protection of plant varieties, an international convention, which is known as “UPOV” (Union pour le protection des obtentions vegatals) and covers the protection of plant varieties, could be referred to for guidance.

The 1978 text of “UPOV” convention has the following broad contents:

(a) As regards the scope, it has been provided that only five genera or species would be protected initially and would be increased to 24 genera or species in eight years,

(b) The term of protection is 15 to 18 years,

(c) The right include production for the purposes of commercial marketing, offering for sale and marketing, and

(d) It is provided that the plant breeders’ right may be abridged to permit acts generally for experimental purposes on his holding of harvested material obtained by planting protected varieties in his own holding.

The main difference between patents and “sui generis” system of plant life protection in the 1978 version of “UPOV” was that the right in the case of the 1978 version of “UPOV” extended only to production for commercial marketing and commercial marketing of propagating material whereas in the case of patents, it would extend to production per se.

If the plant varieties were to be protected by patents, the farmers having bought the protected seeds would not be able to keep back a part of harvested material to be used for sowing in successive crops. But in the “sui generis” system of 1978 version of “UPOV”, on the other hand, the farmer would be entitled to do so.

The 1991 version of “UPOV” moves the system of plant variety protection nearer the patents system by imposing restrictions on the right of the farmers to produce the propagating material even for use on his own holding.

Under the final GATT Act “full discretion” had been given to signatory countries to adopt either the 1978 version or the 1991 version of “UPOV or even to make departures from either of the versions.

In a recommendation of far reaching consequence, the Parliamentary Standing Committee on Commerce, after considering the draft Dunkel proposals expressed the opinion that keeping the interest of the Indian farmers uppermost in mind while dealing with the

issues pertaining to intellectual property rights' application to agriculture, the traditional rights of farmers for preservation, sale and free exchange of seeds must remain unaffected.

The committee also expressed in its report on Dunkel draft that these safeguards should find specific mention in the GATT.

10.9.3 Provision of Subsidy in Indian Agriculture and New GATT Agreement:

The new GATT agreement has stipulated that countries with an aggregate subsidy of more than 10 per cent of the value of total agricultural produce will have to reduce them. Reduction of subsidy to agriculture under the agreement applied to developing countries like India, only if the value of subsidies exceeded 10 per cent of the value of their total agriculture production.

In India, the aggregate value of agricultural subsidies was not only far below the 10 per cent limit but also negative. Currently, the agricultural subsidy in India is ruling at the rate of 5 per cent of the value of agricultural produce compared with far higher rates in Japan and E.U. Clubbing of product and non-product agricultural subsidies will allow much greater flexibility to provide subsidies for agricultural production. Thus, the Dunkel plan would in no way prevent India to subsidies its farmers in non-product specified subsidies like fertilizers, water, seeds, credits and pesticides as they do not exceed five per cent in India. In case of product-specific subsidies such as minimum support price, official estimates show that for 17 out of 20 items subsidies in India remain negative. Only in case of sugarcane, groundnut and tobacco, subsidies remain positive but were still lower than 10 per cent threshold. Thus, under the new agreements, all major agricultural support programmes were exempted from subsidy reduction commitments. These included research, plant protection and disease control, extension services, training, provision of infrastructure, regional assistance programmes, environmental programmes, income support programmes, public stock holding for food security purposes, domestic food aid, crop insurance schemes, investment subsidies and input subsidies for low income and poor farmers. Moreover, under the new agreement, consumer subsidies under the public distribution system (PDS) for the rural and urban poor are legitimate and are thus permitted. Thus, there is an explicit provision for exempting public distribution system from the agreement. Accordingly, PDS in India can therefore be continued.

10.9.4 Conclusion:

Thus, from the Indian perspective the Dunkel Draft on agriculture is a kind of mixed bag with the plus points outweighing the minus. No doubt, the new GATT arrangement will definitely raise the prices of agricultural inputs like HYV seeds, fertilizers, pesticides etc. but with this India's market opportunities in exports of agricultural commodities would increase.

Thus, Indian agriculture and agri-business should get the kind of boost it has never known by exposing itself to the larger world market. The farm lobby would see major growth in exports in superior rice, vegetables, fruit, fisheries and meat products, vegetable oil processed products and flowers. The reduction in export subsidies on agriculture by developed countries will make Indian agricultural exports more competitive in world markets. Thus, Mr. Bibek Deb Roy of Indian Institute of Foreign Trade was of the view that *"If agriculture is liberalised there will be higher input prices. But there will also be higher output prices and it is slightly unfair to look at the hike in input prices alone."*

Thus, under the present context, it can be finally observed that under the new GATT agreement, whatever negative aspects the Indian agriculture will face that can be suitably neutralized by responding to its positive aspects. Thus, if the Indian agriculture can meet the challenges and opportunities open to it and if the developed countries do not put any trade barrier before the flow of Indian agricultural exports then India will definitely be able to overcome this threat and also become successful to gain sufficiently from this new world trade regime.

Check your Progress/ Self Assessment Questions

Who was Arthur Dunkel?

What is TRIPs?

10.10 Let us sum up

In this unit we get the ideas regarding agricultural system in India with various types of agricultural methods adopted by Indian Farmer i.e., primitive subsistence farming, intensive subsistence farming, dry farming, mixed and multiple farming, terrace farming and commercial farming. Then we are able understand aboutdiffusion, adoption, diffusion of innovations, reasons for adoption/ rejection and problems of diffusion of new technology. Then we understand the reason behind the limited spread of Green Revolution. Then we get some idea regarding mode of production debate in India (Rudra, Patnaik and Chattopadhya's views only). Then we had an idea regarding Inter-sectoral Terms of Trade. Then the unit discussed about food security with provision of food subsidy followed by methods of providing food subsidy and current challenges in PDS, Then it explains the relationship between the State

and agriculture followed by WTO and Indian agriculture along with Dunkel Plans and Indian agriculture, further steps taken to protect plant variety by the Government. Finally the unit discuss about the provision of subsidy in Indian agriculture and new GATT agreement,

10.11 Key Terms

Primitive Subsistence Farming: It is typically done on small areas of land; it also uses indigenous tools like a hoe, Dao, digging sticks, etc. Usually, a family or the local communities of Indian farmers are engaged in this farming method that uses the output for their own consumption. This is the most natural method, where the growth of crops but dependent on the rain, heat, fertility of the soil and other environmental conditions.

Intensive Subsistence Farming: This is yet another variation of subsistence farming. In this method, cultivation happens across larger areas of land and thus, it is labor-intensive. Also, to get a high quantity of produce chemical fertilizers and different irrigation methods are used to yield more crops.

Dry farming or Dry-land Farming: It may be defined as a practice of growing crops without irrigation in areas which receive an annual rainfall of 750 mm – 500 mm or even less. Dry land agriculture is subject to high variability in areas sown, yields and output. These variations are the results of aberrations in weather conditions, especially rainfall.

Mixed Farming: It is referred to cultivation of crops and raising of animals simultaneously. The multiple farming is used to denote the practice of growing two or more crops together. In such case a number of crops having varying maturing periods are sown at the same time. This practice is followed is areas having good rainfall or facilities of irrigation.

Terrace Farming: The hill and mountain slopes are cut to form terraces and the land is used in the same way as in permanent agriculture. Since the availability of flat land is limited terraces are made to provide small patch of level land. Soil erosion is also checked due to terrace formation on hill slopes.

Commercial Farming: This type of farming is what contributes to the country's economy with huge volumes of yield. In fact, the crops grown commercially in India are used as an export item across the world. In this farming method, the Indian farmer uses a high amount of fertilizers, pesticides, and insecticides to enhance and maintain the growth of the crops.

Diffusion: It is the process by which an innovation is communicated through certain channels over time among the members of a social system. It is a special type of communication, in that the messages are concerned with new ideas. It is this 'newness' of the idea in the message content of communication that gives diffusion its special character. The

diffusion of innovations is essentially a social process in which subjectively perceived information about a new idea is communicated.

Adoption: A diffusion of innovation with in a social system takes place through its adoption by individual or groups. Adoption is a decision to make full use of an innovation as the best course of action available.

Green Revolution: The dramatic transformation in agriculture practices that involves the use of new methods of cultivation and inputs refers to as Green Revolution in India. The green revolution consists of technological improvements which were mainly adopted to increase agriculture productivity. The green revolution occurs as a result of adoption of new agriculture strategy during mid 60's by Government of India to achieve self-sufficiency in the food grains production. These changes bring about a substantial increase in agriculture production in a short span of time.

Terms of Trade (ToT): It is the relative price of exports in terms of imports and is defined as the ratio of export prices to import prices. It can be interpreted as the amount of import goods an economy can purchase per unit of export goods.

10.12 Answer to 'Check Your Progress'

Q. What's the rank of India in the production of agricultural products?

A. India is the second largest producer of agricultural products in the world.

Q. What are the names of indigenous tools used in primitive subsistence farming?

A. The tools are hoe, Dao, digging sticks, etc.

Q. When the contribution of new technology to economic growth can be realized?

A. The contribution of new technology to economic growth can only be realized when and if the new technology is widely diffused and used.

Q. What is the formula to calculate extent of adaptation?

A. $\text{Extent of Adoption} = \frac{\text{No.of Practices Adopted}}{\text{No.of Practices Recommended}} \times 100$

Q. Why the technological improvements in the green revolution were adopted?

A. The technological improvements in the green revolution were mainly adopted to increase agriculture productivity.

Q. How the green revolution generates the employment opportunities?

A. Green revolution generated employment opportunities into diverse activities which were created as a result of multiple cropping and mechanization of farming.

Q. The concept of rent barrier to the development of capitalist relations in Indian agriculture is developed by which economist?

A. Utsa Patnaik, a Professor of Economics at Jawaharlal Nehru University, developed the concept of a rent barrier to the development of capitalist relations in Indian agriculture.

Q. What is Terms of Trade (ToT)?

A. Terms of Trade (ToT) is the relative price of exports in terms of imports and is defined as the ratio of export prices to import prices.

Q. Which day throughout the globe World Food Day is celebrated?

A. World Food Day is celebrated every year around the world on 16 October.

Q. What is TPDS?

A. Targeted Public Distribution System (TPDS).

Q. What is *Pradhan Mantri Fasal Bima Yojana?*

A. It is a crop insurance policy with relaxed premium rates on the principal sum insured for farmers.

Q. What is Blue Revolution?

A. It's an integrated scheme designed to increase the productivity and profitability from aquaculture and fisheries resources, inclusive of both inland and marine.

Q. Who was Arthur Dunkel?

A. Arthur Dunkel was a former Director General of GATT.

Q. What is TRIPs?

A. Trade Related Intellectual Property Rights (TRIPs)

10.13 Questions and Answers

10.13.1 Short-Answer Questions

Q. What is 'slash and burn' method?

A. In this method, once the crops are grown and harvested, the farmers burn the land. They then move to a clear patch of land for a new batch of cultivation. As a result, the land gains back its fertility, naturally. Because no fertilizers are used for cultivation, the primitive subsistence method yields good quality crops and also retains the properties of the soil.

Q. What are the different names of primitive subsistence farming methods in India?

A. The different names are ‘Jhumming’ in the North-Eastern states of Assam, Meghalaya, Mizoram, Nagaland, Arunachal Pradesh, Manipur, Bastar district of Chattisgarh, and in the Andaman and Nicobar Islands, ‘Bewar’ or ‘Dahiya’ in Madhya Pradesh, ‘Podu’ or ‘Penda’ in Andhra Pradesh, ‘Pama Dabi’ or ‘Koman’ or Bringa’ in Orissa, ‘Kumari’ in the Western Ghats, ‘Valre’ or ‘Waltre’ in South-eastern Rajasthan, ‘Kuruwa’ in Jharkhand and ‘Khil’ in the Himalayan region

Q. What is Intensive Agriculture Development program (IADP)?

A. It was the first major experiment of Indian government in the field of agriculture and it was also known as a “package programme” as it was based upon the package approach. The programme was launched in 1961 after the Community Development Programme lost sheen.

Q. Explain the concept of Green Revolution:

A.The dramatic transformation in agriculture practices that involves the use of new methods of cultivation and inputs refers to as Green Revolution in India. The green revolution consists of technological improvements which were mainly adopted to increase agriculture productivity. The green revolution occurs as a result of adoption of new agriculture strategy during mid 60’s by Government of India to achieve self-sufficiency in the food grains production. These changes bring about a substantial increase in agriculture production in a short span of time.

Q. How the Terms of Trade (ToT) may be influenced?

A. Terms of Trade (ToT) may be influenced by the exchange rate because a rise in the value of a country's currency lowers the domestic prices of its imports but may not directly affect the prices of the commodities it exports.

10.13.2 Long-Answer Questions

Q. Explain the diffusion of innovations in agriculture.

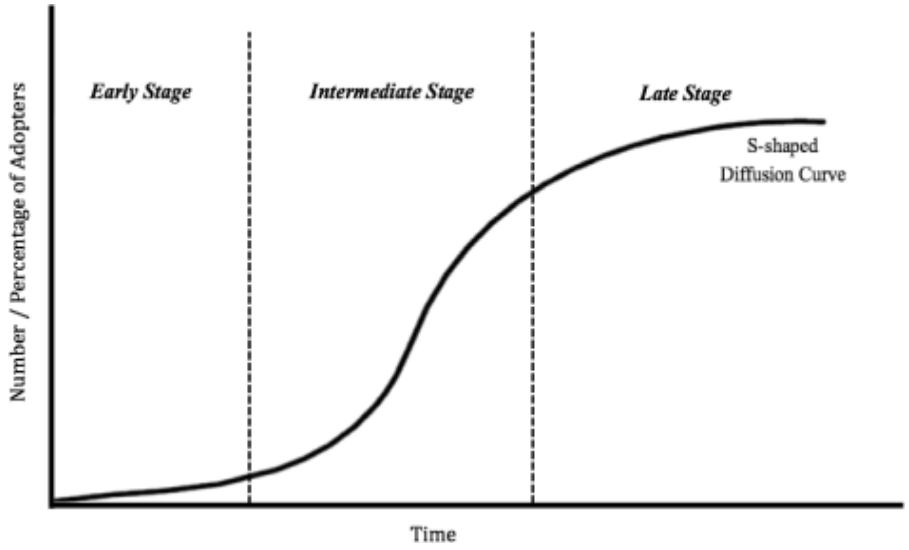
A. Diffusion of innovations refers to the spread of those innovations through a population, and is simply the result of a host of individual adoption decisions.

If individual adoption decisions are, to an extent, predictable, then the larger diffusion process is also predictable. It follows a pattern, and that element of predictability has substantial implications.

Therefore the diffusion process can be explained with the terms given by Rogers as "the spread of a new idea from its source of invention or creation to its ultimate use of adopters". The diffusion of innovations is essentially a social process in which subjectively perceived information about a new idea is communicated.

The process by which an innovation spreads within a social system is called "diffusion". An innovation, however, diffuse within a social system through its "adoption" by individual and groups.

When an innovation is first introduced in a social system, a small proportion of farmers adopt it. Through interaction with these first adopters and observing the results of its use on their farms, a few more farmers come to know about the innovation and its usefulness, and eventually adopt it.



Over the period of time a large number of farmers become familiar with the innovation through interaction with farmers who have already adopted is reflected in the upward slope of the S-shaped diffusion curve. After the majority of the farmers of the social system have adopted the innovation, only a few hard-core resisters are left who have not yet adopted the practice, and they upward slope comes to an end. The remaining part of the curve now has a more gentle slope until the entire village adopts the innovation. Adoption process is a mental process through which a farmer passes from the first stage of acquiring knowledge of an innovation to taking a decision to adopt or reject the innovation and confirmation of this decision. The process consists of following 5 stages.

A. Knowledge: The farmer comes to know about the technology either through his personal contact with extension personnel, peers (friends and neighbours) or through exposure to radio, television, magazines etc. At this stage, the farmer is exposed to the existence of the technology and he develops an understanding about it.

B. Persuasion: In the persuasion stage, the farmer develops a favourable (positive) or unfavourable (negative) attitude towards the technology. This depends upon the extent of knowledge he acquires, the credibility of the source through which he gets the information on the technology and finally how he interprets the information.

C. Decision: The farmer may opt to choose either to adopt or reject the technology. Normally he may not adopt it unless he/she tries it on a small scale himself or he observes the trial by other farmers with similar socio-economic status or by extension personnel who organizes demonstrations on the use of technology. Till this stage, it is a mental exercise, which goes on within an individual.

D. Implementation: In this stage, the farmer implements his decision to adopt or reject the technology. He is more actively engaged in seeking information about the source of availability of the technology, procedure to use it and possible solution for the likely problems he may encounter while using the technology.

E. Confirmation: At this stage the farmer seeks additional information as a reinforcement of the decision already made to confirm whether he has taken the right decision. If the additional information is conflicting with the earlier information, he may possibly alter his decision.

Q. What are the reasons for adoption or rejection of innovation in agriculture?

A. The adoption/rejection of any technology or innovation depends to a great extent on the following elements of technology transfer.

10. Perception of the technology by the farmer under his situation as superior and relatively advantageous than the existing technology or the other way.

2. The farmer's knowledge and attitude towards the technology which in turn depends upon his socio-economic status which include his caste, education, family size, type, herd size, income etc.

3. The quality of extension service and number of extension personnel per thousand farm families and or thousand animals.

4. The extent to which the requisite infrastructure facilities and support services are accessible to the farmers.

Q. Explain the impact of green revolution in Indian agriculture?

A. The green revolution resulted quantitative and qualitative development in the agriculture in India. The quantitative improvement occurs as a result of steep increase in the production

of agriculture output. The qualitative improvement resulted into adoption of modernized technology in the agriculture. The impact of green revolution can be discussed as follows:

1. Spectacular increase in agriculture production: The dependence on food imports is eliminated with the increase in agriculture production. The country becomes self-sufficient in food grains.

2. Improvement in productivity: The tremendous increase in agriculture production occurred as a result of improvements in productivity. The productivity was quite low in the pre-green revolution period. The substantial increase in the productivity occurred in wheat and rice in the earlier periods but later on it spread to other crops also.

3. Increase in Employment: Green revolution generated employment opportunities into diverse activities which were created as a result of multiple cropping and mechanization of farming. It helped to stimulate non-farm economy that generated newer employment in various services such as milling, marketing, warehousing etc.

4. Food grain Price Stability: The adoption of new agricultural technology has led to the increased production and marketable surplus of crops especially food grains that have resulted into price stability of food items.

5. Strengthening of forward and backward linkages with industry: The increase in agriculture production has strengthened the forward linkage of agriculture sector with industry in the sense of supplying inputs to the industry. The backward linkage with the industry has also received a boost as agricultural modernization created larger demand for inputs produced by industry.

Q. What are the problems associated with green revolution?

The new agriculture strategy has resulted into increased productivity and returns for farmers. This has resulted in decline in rural poverty to an extent. However, the revolution resulted into increased income, wide interpersonal and regional inequality and inequitable asset distribution. The major problems associated with green revolution are as follows:

1. Increase in personal inequalities in rural areas: The income inequality between rich and poor increases due to:

a. The owners of large farms were the main adopters' of new technology because of their better access to irrigation water, fertilizers, seeds and credit.

b. Green revolution resulted into lower product price and higher input prices which also encouraged landlords to increase rents or force tenants to evict the land.

c. The mechanization pushed down the wages of and employment opportunities for unskilled labor in the rural areas thereby further widening the income disparities.

2. Increased regional disparities: Green revolution spread only in irrigated and high-potential rain fed areas. The villages or regions without the access of sufficient water were left out that widened the regional disparities between adopters and non-adopters. Since, the HYV seeds technically can be applied only in land with assured water supply and availability of other inputs like chemicals, fertilizers etc.

3. Environmental damage: Excessive and inappropriate use of fertilizers and pesticides has polluted waterway, killed beneficial insects and wild life. It has caused over-use of soil and rapidly depleted its nutrients. The rampant irrigation practices have led to eventually soil degradation. Groundwater practices have fallen dramatically. Further, heavy dependence on few major crops has led to loss of biodiversity of farmers. These problems were aggravated due to absence of training to use modern technology and vast illiteracy leading to excessive use of chemicals.

4. Restrictive crop coverage: The new agriculture strategy involving use of HYV seeds was initially limited to wheat, maize and bajra. The other major crop i.e. rice responded much later. The progress of developing and application of HYV seeds in other crops especially commercial crops like oilseeds, jute etc has been very slow. In fact, in certain period a decline in the output of commercial crops is witnessed because of diversion of area under commercial crop to food crop production.

Q. What are the current challenges in PDS?

A. The current challenged in PDS are:

1. Leakages in PDS: Leakages refer to food grains not reaching intended beneficiaries. According to 2011 data, leakages in PDS were estimated to be 46.7%. Leakages may be of three types: (i) pilferage during transportation of food grains, (ii) diversion at fair price shops to non-beneficiaries, and (iii) exclusion of entitled beneficiaries from the list.

2. Storage: The CAG in its performance audit found that the available storage capacity in states was inadequate for the allocated quantity of food grains. It also noted that in four of the last five years, the stock of food grains with the centre had been higher than the storage capacity available with Food Corporation of India.

3. Quality of food grains: People complained about receiving poor quality food grain which had to be mixed with other grains to be edible. There have also been complaints about people receiving food grains containing alien substances such as pebbles. Poor quality of food may

impact the willingness of people to buy food from fair price shops, and may have an adverse impact on their health.

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