MAHARASHTRA AGRICULTURAL UNIVERSITY EXAMINATION BOARD, PUNE

SEMESTER END EXAMINATION

B.Sc. (Hons.) Agriculture

Semester	:-	IV (New)	**Academic year**	:-	2023-24
Course No.	:-	AGRO-247	**Title**	:-	Farming system and sustainable agriculture
Credits	:-	1+0 = 1	**Total Mark**	:-	40
Day & Date	:-		**Time**	:-	

Note : 1) Solve ANY EIGHT questions from **SECTION "A"**
2) All questions from **SECTION "B"** are compulsory.
3) All questions carry equal marks.
4) Draw neat diagram where ever necessary

SECTION – 'A'

	Marking scheme
Q. 1. Describe the resource recycling in farming system. **Organic recyclable waste include** – crop residues, waste, farm industrial waste, multiple and sewage wastes. They are valuable sources of plant nutrient. In tropical and subtropical soils found in India, there is general deficiency of organic carbon and plant nutrients due to rapid loss of this component by bio- degradation. To make up for these losses, extensive utilization of organic residues in agriculture is essential. In addition, they also protect the soil from erosion. In India, there is a general potential for utilization of crop residues/straw of major crops. About 141.2 MT straws available contribute about 0.7, 0.84, and 2.1 MT NPK, respectively. If considering 50% crop residues utilized as animal feed, the rest can be recycled. Crop residue has wide C: N ratio. Due to this, immobilization of nutrients occurs. Care should be taken that before use, composing with efficient microbial inoculants should be done. **1. Sugarcane Trash Compost:** Fresh sugarcane trash contains 0.36% N with a wide C:N ratio of 122:1. The composted trash contains – higher content of N (1.09) with reduced C:N ratio (20:1). Per hectare availability of trash is about 6- 8 tonnes (over all country about 19 – 38 million tonnes). **2. Bio- gas Slurry:** Organic manures from animal wastes are very important nutrient sources in building up soil fertility. In India, estimated production of dung and urine is about 1002 and 658 million tonnes, respectively. They contribute about 5.7 million tonnes of N P K with proper utilization. Biogas advantages as fuel (gas) and fertilizer (slurry). Dry slurry contains about 1.8 % N, 1.10 % P_2O_5 and 1.50 % K_2O.	0.5 mark 0.5 mark 0.5 mark

3. Vermicompost: The average nutrient content of vermicompost is much higher than that of F.Y.M. vermicompost contains 1.60 % N, 0.54% P_2O_5 and 0.80% K_2O. The C:N ratio of vermicompost is much lower (1.6) than the FYM (1.30).	0.5 mark
4. Industrial Wastes: Among the industrial by products, spent wash from distilleries and molasses and press mud from sugar factories have good manurial value. It is important to use only well decomposed press mud at 10 tonnes / ha. Addition of press mud improves the soil fertility it is reclamation agent in saline and sodic soils. Coir waste is the by-product of coil industry. Well decomposed coir waste of 12.5 t/ha with recommended fertilizer to ground nut and maize increase yield.	0.5 mark
5. Municipal and Sewage Wastes: This is one of the important components of organic wastes. In India, the total municipal refuse is about 12 million tonnes/annum containing 0.5% N, 0.3% P & 0.3% K. Sewage (liquid portion) sludge (solid portion) is available to on extent of 4 million tonnes /annum containing 3% N, 2% P & 0.3% K. Such organic waste can be used carefully. It may contain metals thus hazard to plants, animals & human beings.	0.5 mark
6. Crop residues: Residues left out after the harvest of the economic portion are called crop residues /straw. Cereal straw and residues contain about 0.5% N, 0.6% P and 1.5%. The crop residues can be recycled by way of incorporation compost making or mulch material.	0.5 mark
7. Rice Husk: It is major by- product of the rice milling industries. It is poor source of manure and nutrient 0.3% N, 0.2% P and 0.3% K. Rice husk should be incorporated into the wet soil and can be used in saline and alkaline soils to improve the physical condition. It can also be used as a bedding material for animals.	0.5 mark
Q.2 Describe the classification of farming system based on value of products or income or comparative advantages.	
1. Specialized Farming: The farm in which 50 per cent or more income of total crop production is derived from a single crop is called specialized farming. The farm in which only single crop is cultivated for selling in the market and the income of the farm depends mainly on that crop is called specialized farming by Hopkins.	1 mark
Advantages:	
1. Better use of land: More profitable to grow crops on land best suited to it e.g. jute growing or cultivation on swampy land in west Bengal.	
2. Better marketing: it allows grading, processing, storing, transporting and financing the produce.	
3. Less equipment and labour.	
4. Costly and efficient machinery can be kept: A wheat harvester/thresher can be maintained in a highly specialized wheat farm.	
5. The efficiency and skill of the labour increased: Specialization allows a man to be more efficient and expert at doing a few things.	
6. Farm records can be maintained easily.	
7. Intensity of production leads to relatively large amount of output.	
8. Better management: fewer enterprises on the farm are liable to be less neglected and sources of wastage can easily be detected.	

Disadvantage:

These disadvantages of specialization are evident when the farmer realizes that "all his eggs are in one basket".

1. There is greater risk: When failure of crop and decreasing market price of the product, demand in market of product.
2. It is not possible to maintain soil fertility-lack of crop rotation.
3. The productive resources i.e. land, labour and capital are not fully utilized.
4. Irregular income of the farm as they get income only once or twice in a year.
5. Proper Utilization of resources is not possible.
6. By product of crop are not property utilized, as numbers of livestock's are less in number.
7. Due to specialization of a single enterprise, the knowledge about other enterprises vanishes.
8. Does not help in supplying all the food needs of the family members of the farmer.

1 mark

2. Mixed farming: Mixed farming is one where crop production is combined with the rearing of livestock. The livestock enterprises (cows, buffaloes, sheep goat, and fisheries) are complementary to crop production; so as to provide a balance and productive system of farming. In mixed farming at least 10 per cent of its gross income must be contributed by livestock activity. The upper limit is 49 per cent under Indian conditions. So the farm on which at least 10 to 49 per cent income is found from livestock is called mixed farm. In mixed farming cow and buffaloes are included with crop production.

Advantages:

1. It offers highest return on farm business, as the by-products of farm are properly utilized.
2. It provides work throughout year.
3. Efficient utilization of land, labour, equipment and other resources.
4. The crop by products such as straw, bus, fodder etc. is used for feeding of livestock and in return they provide milk.
5. Manures available from livestock maintain soil fertility.
6. It helps in supplying all the food needs of the family members.
7. Intensive cultivation is possible.
8. If one source of income is lost he can maintain his family from other source of income.
9. Milk cattle's provide draft animals for crop production and rural transport.
10. Mixed farming increases social status of the farmer.

In India the livestock is much closely connected with agriculture because animal power is the main source of power in agriculture. FYM is the main source for maintaining soil fertility and animals make good use of subsidiary and by-products on farms and in turn they provide milk under such circumstances mixed farming will most suit in Indian conditions.

Disadvantages:

1. Indigenous method of cultivation is used till now.
2. Draft and milch animals should be sold when they fail in production.
3. Healthy calf should be reared to replace age old animals.

Required of Mixed Farming:

i) Complicated management practices.
ii) Sound cropping scheme.
iii) Good cattle in suitable number.
iv) Transport facility.
v) Marketing facilities.

1 mark

3. Ranching: A ranch differs from other type of crop and livestock farming in that the livestock graze the natural vegetation. Ranch land is not utilized for tilling or raising crops. The ranchers have no land of their own and make use of the public grazing land. A rancher occupies most of the time of one or more operators. Ranching is followed in Australia, America, Tibet and certain parts of India. **4. Dry Farming**: Farmers in dry land, which receives 750 mm rainfall or even less than that struggle for livelihood. The major farm management problem in these tracts, where crops, which are entirely dependent upon rainfall and the conservation of, soil moisture is needed. Dry Farming Involves the Adoption of the Following Practices: a) Timely preparation of the land to a condition in which it is best able to receive and conserve the available moisture. b) Time and proper inter culturing during growth of the crop. c) Improving the water holding capacity of the soil by the profitable application of organic manure. d) Use of such implements as is capable or rapidly breaking of the surface of the soil. e) Building of fields. f) Use of optimum seed rates. g) Thinning of excess plant populations. h) Mixed cropping. Environmentally sustainable dry land farming systems emphasizes conservation and utilization of natural resources. Agronomic practices of conservation, tillage and mulch farming, rotational cropping, use of legumes and cover crops for improving soil fertility and suppressing weeds and efficient uses of cattle manure are some of the components of sustainable farming system.	1 mark
Q. 3 Describe in detail about the factors to be considered for fertilizer schedule in sequential cropping system. **Fertilizer Application:** Determining the fertilizer schedule is complex in sequential cropping system as several factors have to be considered. The important factors are: soil supplying power, total uptake by crops, residual effect of fertilizers, nutrients added by legume crop, crop residues left on the soil and efficiency of crops in utilizing the soil and applied nutrients. **1. Soil Supplying power.** Soil contribution to the crops should be known before deciding on the quantum of fertilizer application. The results of long term fertility trials revealed that there is no appreciable change in the soil physical properties and soil deficiency for micronutrients as a consequence of multiple cropping. The soil nutrient status, estimated by soil analysis at the beginning of the season is altered by growing different crops during different seasons. The soil supplying power increases with legume in rotation, fertilizer application and addition of crop residues. The available nitrogen and potassium in soil- after groundnut crop are higher compared to initial status of the soil. But after pearl millet, only potassium status in the soil is improved and there is no change in phosphorus status. **2. Nutrient Uptake by Crops:** The total amount of nutrients taken by the crops in one sequence gives an indication of the fertilizer requirement of the system. Balance sheet approach is followed to know whether the amount of fertilizers applied is equal, more or less to the total uptake of nutrients by different crops in the system. The balance is obtained by subtracting the fertilizer applied to crops in the system from the nutrients taken up by the	1 mark

crop. **3, Residual Effect of fertilizers:** The extent of residues left over in the soil depends on the type of fertilizer used. Because of their mobility and solubility, nitrogenous fertilizers leave no residues after the crop is harvested. However, residues of nitrogen occur only when previous crop yields are poor. Phosphatic fertilizers and farmyard manure leave considerable residue in the soil which is useful for subsequent crops. Farmyard manure applied to the previous crops used only 50 per cent of its nutrients and rest was available for subsequent crops. The residues left by potassium fertilizers are marginal. **4. Legume Effect:** Legumes add nitrogen to the soil in the range of 15 to 120 kg N ha^{-1}. The amount of nitrogen added depends on the crop and also on the purpose for which it is grown. Green gram grown for grain contributes 15 to 20 kg N ha^{-1} to the succeeding crop. Cowpea grown for grain and fodder contributes 24 and 30 kg N ha^{-1}, respectively to the succeeding crop. Inclusion of leguminous green manures in the system adds 40 to 120 kg N ha^{-1}. The availability of phosphorus is also increased by incorporation of green manure crops. Potassium availability to subsequent crop is also increased by groundnut. **5. Crop Residues:** Crop residues add considerable quantity of nutrients to the soil. Deep rooted crops like cotton and red gram absorb phosphorus and other nutrients from deeper layers. Leaf fall and its subsequent decomposition add phosphorus to the top layers. Crop residues containing high C: N ratio like stubble of sorghum and pearl millet temporarily immobilize nitrogen. Residues of leguminous crops contain low C: N ratio and, they decompose quickly and release nutrients. **6. Efficiency of crops:** Crops differ in their ability to extract and forage nutrients from different layers of soils and their capacity to utilize them to produce economic products. Jute is more efficient crop for utilization of nitrogen followed by summer rice, rainy-season rice, maize, potato and groundnut in that order. The order of phosphorus efficient crops is jute > summer rice>kharif rice> potato> groundnut > maize. Groundnut is more efficient in potassium utilization and the other crops their order of efficiency is maize, jute, summer rice, rainy-season rice and potato. Fertilizer recommendation should be made to the cropping system considering all the above factors. For example, in wheat-based cropping systems, an extra dose of 25 per cent nitrogen is recommended for wheat when it is grown after sorghum or pearl millet. Wheat after pulse crops like red gram, green gram or black gram needs 20 to 30 kg less nitrogen per hectare. When phosphatic fertilizers are added to green manure crop, there is no necessity to apply phosphorus to succeeding wheat crop. In rice-wheat cropping system, recommended dose of nitrogen of crops must be applied. However, it is sufficient to apply phosphorus to wheat and potassium to rice but not for both crops of the system. Thus, lot of fertilizer can be saved by following system approach in fertilizer recommendation.	1 mark 2 mark
Q. 4. Define multiple cropping and give in detail its classification. **Multiple Cropping or Poly-cropping:** It is a cropping system where two or three crops are gown annually on the same piece of land using high input without affecting basic fertility of the soil. Growing two or more crops on the same piece of land in one calendar year is known as multiple cropping.	1 marks

1. Polyculture: Cultivation of more than two types of crops grown together on a piece of land in a crop season. e.g. 1) Subabul + Papaya + Pigeon pea + Dinanath grass. 2) Mango + Pine apple + Turmeric 3) Banana + Marigold + berseem.	0.5 mark
2. Relay Cropping or Overlapping Cropping: Growing the succeeding crop when previous crop is at its maturity stage-or-sowing of the next crop immediately after the harvest of the standing crops. Or it is a system of cropping where one crop stands over land to the crop in quick succession. e.g. 1) Paddy - lathyrus 2) Paddy - Lucerne. 3) Cotton - Berseem. 4) Rice – Cauliflower – Onion - summer gourds. **Advantages:** 1. Minimum tillage is needed for relay cropping and primary cost of cultivation is less. 2. Weed infestation is less, as land is engaged with crops year round. 3. Crop residues are added in the soil and thus more organic matter. 4. Residual fertilizer of previous crops benefits succeeding crops.	1 mark
3. Inter cropping: Growing of two or more crops simultaneously on the same piece of land with a definite row pattern e.g. growing setaria + red gram in 5:1 ratio i.e. after every 5 rows of setaria one row of red gram is sown. Thus, cropping intensity in space dimension is achieved. Multiple cropping in the form of intercropping is predominant in the regions of dry, humid and semi-arid tropics. The objectives of Intercropping Systems are: 1. Insurance against main crop failure under aberrant weather conditions or pest epidemics. 2. Increase in total productivity per unit land area. 3. Judicious utilization of resources such as land, labour and inputs. Intercropping was originally practiced as an insurance against crop failure under rainfall conditions. At present the main objective of intercropping is higher productivity per unit area in addition to stability in production. Intercropping systems utilizes resources sufficiently and their productivity is increased. When two crops are to be grown together, they are chosen in such a way that there is variation in their growth duration. The peak periods of growth of the two crops species should not coincide. In such arrangements, a quick maturing crop completes its life cycle before the other crop starts. Willey (1979) described the concept as temporal complementary i.e. greater differences in maturity and growth demands of the crop components, more opportunity is provided for greater exploitation of growth factors and over yielding. This will be achieved either by generic difference in crop species or manipulation of planting dates. Normally short and long duration crops are grown together. Based on the per cent of plat population used for each crop in	1.5 mark

intercropping system, It is divided in to two *viz*; additive series and replacement series.

Additive Series: Which is mostly adopted in India, one crop is sown with 100 per cent of its recommended population in pure stand, which is known as the base crops. Another crop known as intercrop is introduced into the base crop by adjusting or changing geometry. The population of intercrop is less than its recommended population in pure stand. LER of additive series is greater than replacement series. Additive series is more efficient than replacement series in intercropping system.

Replacement series: In replacement series both the crops are called component crops. By scarifying certain proportion of population of none component, another component is introduced. This type of intercropping is practiced in western countries.

Component Crop: is used to refer to either individual crops making up the intercropping situation.

Intercrop yield is the yield of a component crop when grown in intercropping and expressed over the total intercropped area. (i. e. area occupied by both the crops). A simple addition of both the intercrop yields a combined intercrop yield.

Base Crop: is the one which is planted as its optimum sole crop population in an intercropping situation and second crop is planted in between rows of base crop for obtaining bonus yield from intercrop without affecting base crop yield.

Q.5 Describe interaction between component crops in inter cropping.

Plant interactions

Interactions between component crops

In intensive cropping, crops are grown in association (intercropping) or in sequence (sequential cropping). In such situations there is possibility of interaction between the component crops. The interaction is mainly due to response of one species to the environment as modified by the presence of other species. Interaction may be competitive or non-competitive or complementary.

Interactions in intercropping

Factors such as light, water, nutrients, oxygen and CO_2 are required for plant growth. In mixed or intercropping situations, the component species compete for the growth factors. The proximity of the species causes sub-optimal utilization of the growth factors and hence there is inequitable distribution of resources among the plants. Generally, competition will develop between two components or within the components.

Light: Intercropping can increase light inception by as much as 30-40 per cent. When one component is taller than the other in an intercropping system, the taller component intercepts most of the solar radiation. In intercropping situation where the component crops have different growth durations, the peak demand for light would occur at different times. In such combinations, competition for light is less among the component crops and there is greater light use in intercropping than in pure stands. In general, the component crops under intercropping situations are grown in such a way that competition for light is minimized. Proper choice of crops and varieties, adjustment of planting density and pattern are the techniques to reduce competition and increase the light use efficiency.

1 mark

Moisture and nutrients: Competition for water and nutrients results in two main types of effects on the less successful or suppressed component. First, the roots of dominated crop may grow less on the sides of aggressive component. The suppressed components adapt to such conditions by increased capacity for uptake. Also, if one part of the root system is on the depleted side, the remaining part shows compensatory activity and vigour. Secondly, plants affected by competition for soil factors are likely to have increased root/shoot ratio. **Allelopathy:** Allelopathy is any direct or indirect harmful effect that one plant has on another through the release of chemical substances or toxins into the root environment. Some crops may be unsuitable to be grown as intercrops because they may produce and excrete toxins into the soil which are harmful to other components. **Annidation:** Annidation refers to complementary interaction which occurs both in space and time. **Annidation in Space:** The canopies of component crops may occupy different vertical layers with taller component tolerant to strong light and high evaporative demand and shorter component favouring shade and high relative humidity. Thus, one component crop helps the other. Multistoreyed cropping in coconut gardens and planting of shade trees in coffee, tea and cocoa plantations use this principle. Similarly, root systems of component crops exploit nutrients from different layers thus utilizing the resources efficiently. Generally, one component with shallow root system and another with deep root system are selected for intercropping as in *Setaria* (shallow) + red gram (deep) intercropping system. **Annidation in Time:** When two crops of widely varying duration are planted, their peak demands for light and nutrients are likely to occur at different periods, thus reducing competition. When the early maturing crop is harvested, conditions become favourable for the late maturing crop. This has been observed to occur in sorghum + red gram, groundnut + red gram and maize + green gram intercropping systems. **Other Complementary Effects:** In an intercropping system, involving a legume and a non-legume, part of the nitrogen fixed in the root nodule of the legume may become available to the non-legume component. The presence of rhizosphere microflora and mycorrhiza on one species may lead to mobilization and greater availability of nutrients not only to the species concerned, but also to the associated species. Another example is the provision of physical support by one species to the other in intercropping system. Erect crop plants may improve the yield of a climber as in-the case of coconut +pepper, maize + beans. The taller component acts as wind barrier protecting the short crop as in maize + groundnut, onion + castor and turmeric + castor.	1mark 1mark 1 mark
Q. 6 Describe in brief the assessment tools for determining efficiency of cropping system based on land use. **1. Land Use Efficiency** **(a) Multiple Cropping Index or Multiple Cropping Intensity (MCI):** It was proposed by Dalrymple (1971). It is the ratio of total area cropped in a year to the total land area available for cultivation and expressed in percentage. $$MCI = \frac{\sum_{i=1}^{Nc} a_i d_i}{A} \times 100$$	1 mark

Where, i = 1,2,3…….. n,

n = total number of crops,

ai = area occupied by i^{th} crop

A = total land area available for cultivation.

It is similar to cropping intensity.

(b) Cultivated Land Utilization Index (CLUI): Cultivated land utilization index (Chuang, 1973) is calculated by summing the products of land area planted to each crop, multiplied by the actual duration of that crop divided by the total cultivated land area, times 365 days. 1 mark

$$CLUI = \frac{\sum_{i=1}^{Nc} a_i d_i}{A \times 365}$$

Where, i = 1,2,3…..n,

n = total number of crops,

ai = area occupied by the i^{th} crop,

di = days that the i^{th} crop occupies

A = total cultivated land area available for 365 days.

CLUI can be expressed as a fraction or percentage. This gives an idea about how the land area has been put into use. If the index is 1 (100 %), it shows that the land has not been left fallow and more than 1, speaks about the specification of intercropping and relay cropping. Limitation of CLUI is its inability to consider the land temporarily available to the farmer for cultivation.

(c) Crop Intensity Index (CII): Crop intensity index assesses farmer's actual land use in area and time relationship for each crop or group of crops compared to the total available land area and time, including land that is temporarily available for cultivation. It is cultivated by summing the product of area and duration of each crop divided by the product of farmer's total available cultivated land area and time period plus the sum of the temporarily available land area with the time of these land areas actually put into use (Menegay *et al.*, 1978). The basic concept of CLUI and CII are similar. However, the latter offers more flexibility when combined with appropriate sampling procedures for determining and evaluating vegetable production and cropping pattern data. 1 mark

(d)Specific Crop Intensity Index

$$SCII = \frac{\sum_{i=1}^{Nc} a_i t_i}{AoT \sum_{j=1}^{M} A_j T_j}$$ 1 mark

Where, i = 1,2,3…..Nc,

Nc = total number of crops grown by a farmer during the time period, T,

ai = area occupied by i^{th} crop,

ti = duration of i^{th} crop (months that the crop i occupied an area ai),

T = time period under study (usually one year),

Ao = Total cultivated land area available with the farmer for use during the entire time period, T,

M = total number of fields temporarily available to the farmer for cropping during time period, T,

j = 1,2,3…… M,

Aj = land area of jth field

Tj = time period Aj is available.

CII = 1 means that area or land resources have been fully utilized and less than 1 indicates underutilization of resources.

Q. 7. Define sustainable agriculture and give its importance in agriculture.

Sustainable agriculture involves farming systems that are environmentally sound, profitable, productive, and compatible with socioeconomic conditions. 0.5 mark

Importance

The modern agricultural practices which are heavily dependent on the use of chemical pesticides, inorganic fertilizers and growth regulators has raised the agricultural production manifold but at the cost of resource depletion, environmental deterioration and loss of crop diversity. Therefore it was realized that the modern agriculture is not sustainable in long run, hence the concept of sustainable agriculture emerged which not only emphasizes on the conservation of the natural resources but also maintains the quality of environment. Often there is misconception that sustainable agriculture and organic agriculture is the same thing. 1.5 mark

However, it is not true, as both are different concepts. In sustainable agriculture chemical fertilizers and pesticides are often used in a limit that has no any disruptive effect on the soil and the environment. However, organic agriculture strictly avoids the use of chemical fertilizers and pesticides. Therefore, sustainable agriculture is a broad term which includes organic agriculture as well. Sustainable agriculture is in fact the successful management of resources for agriculture to satisfy the changing human needs, while maintaining or enhancing the quality of environment and conserving the natural resources. 2 marks

It is a balanced management system of renewable resources including soil, wildlife, forests, crops, fish, livestock, plant genetic resources and ecosystems without degradation and to provide food, livelihood for current and future generation maintaining and improving productivity and ecosystem services of these resources.

Sustainable agriculture systems are designed to use existing soil nutrient and water cycles, and naturally occurring energy flows for food production. Furthermore, such systems aim to produce food that is both nutritious and without products that harm human health. In practice, such systems have tended to avoid as far as possible the use of chemical fertilizers, pesticides, growth regulators, and livestock feed additives, instead relying upon crop rotations, crop residues, animal manures, legumes, green manures, off-farm organic wastes, mechanical cultivation and mineral bearing rocks to maintain soil fertility and productivity and on natural biological and cultural controls for insects, weeds, and other pests.

Chemical fertilizers and pesticides dependent modern agricultural practices have caused several problems. In modern agriculture there has been consistent use of few high yielding hybrid crop varieties which has resulted into the depletion of land varieties (desi varieties) that are not only nutritious but also possess several useful characters like drought, disease and pest resistance. The gradual loss of variability in the cultivated forms and in their wild relatives is referred to as genetic erosion. This variability arose in nature over a long period of time and if lost, would not be reproduced during a short period.

Therefore genetic erosion has emerged as major problem of modern agriculture. Overuse of inorganic fertilizers has led to the problem of soil erosion. Fertilizers destroy the soil structure making the soil susceptible to erosive forces like water and wind. Overuse of nitrogenous fertilizer urea has caused the soil acidity. Excessive nitrogen suppresses biological activity including mycorrhizae (non-pathogenic association of fungi with roots of

plants which helps in phosphorus uptake by plants), reduce nodulation in leguminous plants give a competitive advantage to the weed over crop and increase pest incidence.

Mismanagement of surface and ground water resources has led to the problem of water logging, soil salinity and alkalinity. Moreover, extraction of water for irrigation has caused the lowering of ground water table. Deforestation has resulted into the problem of global warming, depletion of biological diversity, drought and the siltation of water reservoirs.

Modern agricultural practices have also enhanced the ozone depletion. Nitrous oxide (N2O) produced by microbial action on the nitrogenous fertilizers is responsible for the thinning of the stratospheric ozone layer which provide protection against the harmful ultra violet radiation of the sun. Excessive use of pesticides to control pests in modern agriculture practices has led to the problem of pesticide resistance resulting into the rise of pest population. In addition to this, pesticides are also responsible for the environmental pollution which indirectly or directly affects the human health.

The management practices for sustainable agriculture virtually differ from those of modern agriculture. The important steps in sustainable agriculture are conservation of crop diversity, conservational tillage, watershed management, efficient water management, integrated nutrient management, integrated weed management integrated pest management and crop diversification. Generally, the management practices in sustainable agriculture are aimed at achieving sustainable production with limited or no chemical inputs with priority to farm-grown inputs without pollution and minimum damage to natural resource base.

Q. 8. Describe in short, the low external input technologies in crop production. — 1 mark

Low input farming systems "seek to optimize the management and use of internal production inputs (i.e. on-farm resources) and to minimize the use of production inputs (i.e.off-farm resources), such as purchased fertilizers and pesticides, wherever and whenever feasible and practicable, to lower production costs, to avoid pollution of surface and groundwater, to reduce pesticide residues in food, to reduce a farmer's overall risk, and to increase both short- and long-term farm profitability." — 3 marks

Low input technologies in crop production:

Land Preparation: The uses of ruminant farm animals such as cattle sheep and goats to clear bushes and old stalk residues of harvested crops has been practiced in mixed farm yield low input technology.

Low input technologies organic farming crop enterprise: Low input technologies used in soil fertility are ashing, cattle manure, green manure, mulching, urine-manure maintaining slurry and manure technology.

Alley farming technology: It is a multipurpose agro-forestry system involving the cultivation of nitrogen fixing tree crops in rows sufficiently spaced to accommodate 4-6 rows of food crops.

Urine - Manure slurry technology: Slurry (a thick liquid mixture of animal manure and urine from a livestock shed makes a good organic fertilizer because it is rich in Nitrogen and organic matter. It is usually applied directly around the crop stand.

Manure technology: Fresh manure from cattle, chickens, goats, rabbits or sheep in a mixture, is diluted for foliar application /top dressing. It improves vegetative growth and fruiting.

Cereals and pulses low input pest space control and storage devices: Grains and legumes are commonly stored in airtight containers and bags but due to poor management of the structure, pests, often destroy these valuable. A number of cheap items such as pepper fruits, ash, lime leaf, neem seeds are active against pests of cereals and legumes such as weevils and beetles. A ground mixture of two or more of the items applied the rate of 10-20 g per kg of the stored product offers protection for about one year.

Low input bio-pesticides or organic farming: Bio-pesticides are cheaper to produce and easy to use. About 235 plant families produce over 24,000 species known and used as bio-pesticides

Q. 9 Define farming system and give its concept and objectives. 1 mark

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 Concept 2 mark

Farming system is a complex inter related matrix of soil, plants, animals, implements, power, labour, capital and other inputs controlled in parts by farming families and influenced to varying degree by political, economic, institutional and socials forces that operate at many levels. Thus farming system is the result of a complex interaction among a number of interdependent components. Farm activities interact with market forces (socio-economic) and ecosystem (biophysical) for purchasing inputs and disposing outputs by utilizing and degrading natural resources (land, water, air, sunshine etc.).

A farm is a system in that it has **INPUTS, PROCESSES** and **OUTPUTS**

INPUTS - these are things that go into the farm and may be split into *Physical Inputs* (e.g. amount of rain, soil) and *Human Inputs* (e.g. labour, money etc.)

PROCESSES - these are things which take place on the farm in order to convert the inputs to outputs (e.g. sowing, weeding, harvesting etc.)

OUTPUTS - these are the products from the farm (i.e. wheat, barley, cattle)

Depending on the type of farming e.g. arable/pastoral, commercial/subsistence, the type and amount of inputs, processes and outputs will vary. Income through arable farming alone is insufficient for bulk of the marginal farmers. The other activities such as dairying, poultry, sericulture, apiculture, fisheries etc. assume critical importance in supplementing their farm income.

The modern agriculture emphasizes too more dimensions *viz.*, time and space concept. Time concept relates to increasing crop intensification in situation where there is no constraint for inputs. In rainfed areas where there is no possibility of increasing the intensity of cropping, the other modern concept (space concept) can be applied. In space concept, crops are arranged in tier system combining two or more crops with varying field duration as intercrops by

suitably modifying the planting method. Income through arable cropping alone is insufficient for bulk of the marginal farmers. Activities such as dairy, poultry, fish culture, sericulture, bio-gas production, edible mushroom cultivation, agro-forestry and agri-horticulture, etc., assumes critical importance in supplementing farm income. It should fit well with farm level infrastructure and ensures full utilization of bye-products. Integrated farming system is only the answer to the problem of increasing food production for increasing income and for improving the nutrition of small-scale farmers with limited resources. Livestock raising along with crop production is the traditional mixture of activities of the farmer all over the country, only the nature and extent varies from region to region. It fits well with farm level infrastructure, small land base and abundant labour of small man and ensures full utilization of by-products. Sustainability is the objective utilization of inputs without impairing the quality of environment with which it interacts. Therefore, farming system is a process in which sustainability of production is the objective. The overall objective is to evolve technically feasible and economically viable farming system models by integrating cropping with allied enterprises for irrigated, rained, hilly and coastal areas with a view to generate income and employment from the farm. **The Specific Objectives are:** 1. To identify existing farming systems in specific areas and access their relative viability. 2. To formulate farming system models involving main and allied enterprises for different farming situations. 3. To ensure optional utilization and conservation of available resources and effective recycling of farm residues within system and to maintain sustainable production system without damaging resources/environment. 4. To raise overall profitability of farm household by complementing main/allied enterprises with other. 5. To maintain sustainable production system without damaging resources/environment.	1 mark
Q. 10. Give the criteria for enterprise selection and describe the types of enterprises in farming system. **Criteria for enterprise selection** The basic points that are to be considered while choosing appropriate enterprise in IFS are, 1. Soil and climatic features of an area/locality. 2. Social status of the family and social customs prevailing in the locality. 3. Economic condition of the farmer (Return/income from the existing farming system). 4. Resource availability at farm and present level of utilization of resources. 5. Economics of proposed IFS and credit facilities. 6. Farmer's managerial skill. 7. Household demand. 8. Institutional infrastructure and technological knowhow.	1 mark

9. Market facilities. **Types of Enterprises** 1. Independent enterprises, 2. Joint enterprises, 3. Supplementary enterprises, 4. Complementary enterprises and 5. Competitive Enterprises **1. Independent Enterprises:** Independent Enterprises are those which have no direct bearing on each other, an increase in the level of one neither help not-hinders the level of other. In such cases each product should be treated separately e.g. production of wheat and maize independently. **2. Joint Enterprises:** Joint products are those which are produced together e.g. cotton and cottonseed, wheat and straw etc. the quantity of one product decides the quantity of the other products. In case of joint products there is no economic decision taken with respect to the combination of products and two products can be treated as one. **3. Supplementary Enterprises:** Two products are said to be supplementary when an increase in the level of one does not adversely affect the production of the other but adds to the income of the farm i.e. enterprise which do not complete with each other but adds to the total income. For example, on many small farms dairy enterprise or a poultry enterprise may be supplementary to the main crop enterprises because they utilize surplus family labour and shelter available and perhaps even some feeds, which would otherwise go to waste. Sometime enterprises are supplementary for one resource but competitive for another. In such cases the relationship should be treated as one of competitive. Even though they are supplementary to one another in respect of other sources e.g. mixed crops. **4. Complementary Enterprises:** Complementary enterprises are those, which add to the production of each other e.g. Berseem and maize crops. Two products are complementary when the transfer of available input for the production of the one product to the production of the other results in increases in the production of both products. Then two crops are complementary enterprises, the use of resources for the two crops result in the increased production of both the crops. Two enterprises do not remain complementary over all possible combinations. They become competitive at some stages. When both complementary and competitive relationship occurs, the complementary relationship occurs first and then is followed by competitive relationship. **5. Competitive Enterprises:** Competitive enterprises are those which compete for use of the farmers' limited resources, use of resources to produce more of the one necessitates a sacrifice in the quantity of other product. When enterprises are competitive two things determine the exact combination of the product, which would be most	3 mark

profitable. a. The rate at which one enterprises substitute for the other. b. Prices of the products and c. The cost of producing the product. The rate at which one product substitutes for another is known as the marginal rate of substitution.	
SECTION-B	
Q.11 Define the following term 1. **Conservation agriculture:** Conservation agriculture is a management system that maintains a soil cover through surface retention of crop residues with no till/zero and reduced tillage. Or CA is described by FAO as a concept for resource saving agricultural crop production which is based on enhancing the natural and biological processes above and below the ground. 2. **Allelopathy:** Allelopathy is any direct or indirect harmful effect that one plant has on another through the release of chemical substances or toxins into the root environment. 3. **Cropping Systems:** Cropping systems, an important component of a farming system, represents a cropping pattern used on a farm and their interaction with farm resources, other farm enterprises and available technology, which determine their character. **4. Multiple Cropping Index or Multiple Cropping Intensity (MCI):** It is the ratio of total area cropped in a year to the land area available for cultivation and expressed in percentage (sum of area planted to different crops and harvested in a single year divided by total cultivated area times 100).	
Q.12 Fill in the blanks 1. **Sheep and goat** animal component is recommended in dry land area. 2. In sequential cropping, the preceding crop has considerable influence on the succeeding crop mainly by changes in **Structure** of the soil condition. 3. The phytophagous fish **Catla, rohu** and **mrigal** can be combined in a composite fish culture system. 4. Two products/enterprises are said to be **competitive** when an increase in the level of one adversely affect the production of the other.	

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