Cropping systems, cropping intensity and farming systems

Part 1 of 2



Cropping systems, cropping intensity and farming systems

After this chapter you can name the ways crops follow one another or share one field in a year. You can also work out how fully a farm uses its land, and say how a farm links its crops with its animals.



The ways crops follow one another



Crops share one field in a year



How a farm links its crops with its animals

Start with these questions

Try these four questions before you read. The answers come in "Check yourself" at the end.

1. A district has a net sown area of 100 thousand hectares and a gross cropped area of 150 thousand hectares. What is its cropping intensity?
   - A. 66.7 per cent
   - B. 250 per cent
   - C. 150 per cent
   - D. 50 per cent
   - E. 100 per cent
2. A farmer sows lentil seed into a standing rice crop a little before the rice is harvested, so the lentil uses the moisture left in the field. What is this practice called?
   - A. Sequential cropping
   - B. Relay cropping
   - C. Mixed cropping
   - D. Alley cropping
   - E. Ratoon cropping
3. Two crops grow at the same time on the same field in both mixed cropping and intercropping. What sets intercropping apart?
   - A. The crops grow in the same season.
   - B. Two crops are taken in one year.
   - C. Animals are kept with the crops.
   - D. The seeds of both crops are mixed and scattered together.

- E. The crops grow in a definite row pattern.

4. Which idea lies at the core of an integrated farming system?
   - A. The recycling of by-products and wastes between enterprises
   - B. One enterprise run on a large scale
   - C. Growing only one crop on the whole farm
   - D. Buying all inputs from outside the farm
   - E. Keeping the crops and the animals on separate farms

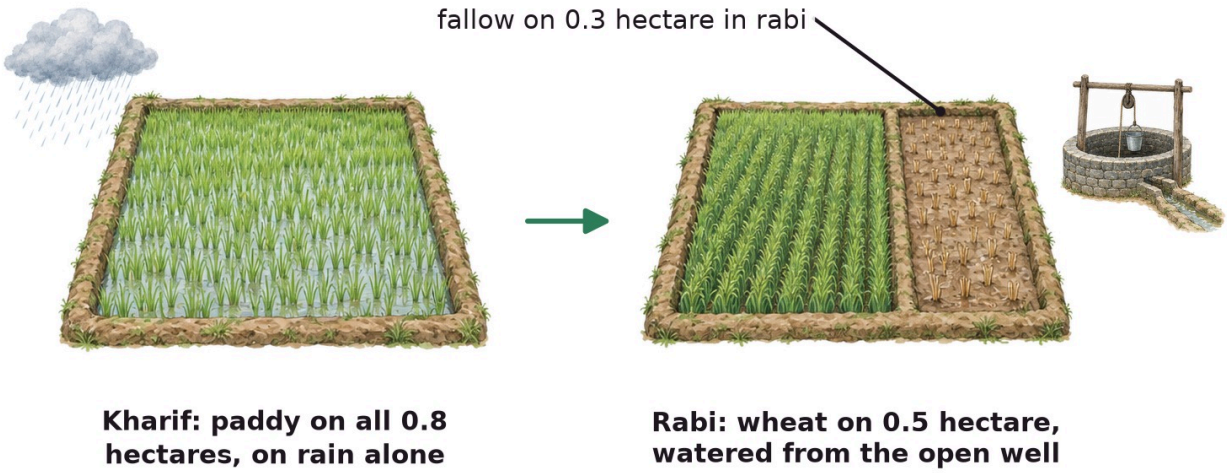
Before you start

This topic covers the whole farm year: which crops follow one another or grow side by side on the same land. The topic "Dryland agriculture and managing rain failure" in this chapter turns to farms that live on rain alone.

You need these words.

- Kharif and rabi: kharif crops grow in the rainy season, and rabi crops grow in winter.
- Legume: a plant of the pea and bean family, with Rhizobium bacteria in its roots that fix nitrogen.
- Variety: a group of plants of one crop with the same set of traits.

These words were taught in "Crop classification, seasons and factors affecting production", "How a crop plant lives and produces yield" and "Seed, seed quality, varieties and the seed chain".



The family's year is the example on almost every page: paddy in kharif and wheat on part of the land in rabi.



The buffalo eats the paddy straw

its dung goes back on the field as manure

The basics: the language of the cropping year

Cropping pattern

A **cropping pattern** is the yearly sequence and spatial arrangement of crops, or of crops and fallow, on a given area.

Cropping pattern: the yearly sequence and spatial arrangement of crops, or of crops and fallow



Sequence: the order of crops through the year

Spatial arrangement: how they are laid out on the land

Fallow: land left without a crop for a time

For example, in a village the low fields carry paddy in kharif. In rabi part of them carry wheat and part lie empty. One word, the cropping pattern, names this whole picture.

"Sequence" means the order of crops through the year. "Spatial arrangement" means how they are laid out on the land. Fallow is land left without a crop for a time. So the pattern includes the empty months too.

On the family's farm, the cropping pattern is paddy on all its land in kharif, then wheat on part of it and fallow on the rest in rabi. The fallow part is in the pattern, because the meaning counts fallow as well as crops.

Patterns are built on the climate, the soil and the water a place has, so that the natural resources are used well. That is why the pattern changes from place to place.

Patterns are built on



the climate | the soil | the water

In drylands most of the coarse grains are grown



sorghum | pearl millet | finger millet

For example, dry land has little water, so in drylands most of the coarse grains, such as sorghum, pearl millet and finger millet, are grown.

Try it 1: A village grows maize in kharif on all its fields and then leaves half the land empty in rabi while the other half carries mustard. Is the empty half part of the village's cropping pattern? Give the reason.

Cropping system

A **cropping system** is the cropping patterns used on a farm, together with how they work with the farm resources, the other farm enterprises and the technology on hand.

Cropping system: a combination of crops in time and space



In time: the crops occupy different growing periods



In space: they are planted among each other in the same field

For example, the family decides how its crops use its land, its water, its labour and its buffalo. The pattern only says what grows where. The system adds how the pattern works with everything else on the farm.

A shorter meaning is a combination of crops in time and space. In time, the crops occupy different growing periods. In space, they are planted among each other in the same field.

A good cropping system should give food for the family, fodder for the cattle and enough cash income. On the family's farm, the paddy gives grain to eat and straw for the buffalo, and the wheat gives grain to eat and to sell. So its cropping system meets all three aims, because each crop does a job for the household.

A good cropping system should give

food for the family



Paddy: grain to eat

fodder for the cattle



Straw for the buffalo

enough cash income



Wheat: grain to eat and to sell

To see the difference between the two words, use one test. The pattern is the picture of crops on the land. The system is that picture plus how it works with the farm's resources and enterprises. So one pattern managed with different resources or technology is a different cropping system.

Two farms may both grow paddy then wheat



Waters the wheat from a well and feeds the straw to a buffalo



Waters from a canal and keeps no animal

The pattern is the same, but the cropping systems differ

For example, two farms may both grow paddy then wheat. One waters the wheat from a well and feeds the straw to a buffalo, and the other waters from a canal and keeps no animal. The pattern is the same, yet the cropping systems differ.

Try it 2: A note says, "The farm grows paddy, then wheat, and the paddy straw feeds the farm's buffalo." Which part describes the cropping pattern, and which part shows the cropping system?

Sole cropping

A farmer on a canal-watered plot sows one wheat variety over the whole field and nothing else. Every plant in the field is the same. This is the simplest use of a field.

Sole cropping is growing one crop variety alone, in a pure stand, at normal density in a field at a given time.



Sole cropping

One crop variety alone, in a pure stand, at normal density

Generally done on irrigated farms

A pure stand means only that crop grows there. "Normal density" means the usual number of plants for that crop. Sole cropping is generally done on irrigated farms.

On the family's farm, the wheat field is a sole crop. It is one crop alone in its field, so it fits the meaning.

Try it 3: In one field, only one variety of mustard is sown at its usual spacing. In another field, mustard and chickpea seeds are sown together. Which field is under sole cropping?

Multiple cropping

The family grows paddy and then wheat on part of the same land in one year. Its neighbour grows paddy and then gram. The exam has one name for any use of one field for more than one crop in a year.

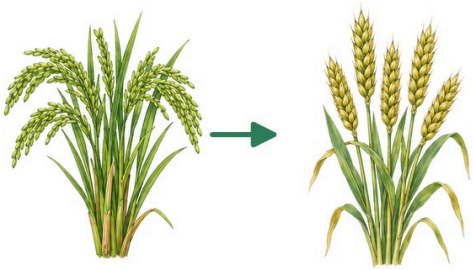
Multiple cropping is growing two or more crops on the same field in a year.

It makes the cropping more intense in time, in space, or in both. A growing population is the reason. More people need more output from each unit of area, time and resources.

On the family's farm, the field with paddy then wheat is under multiple cropping, because it carries two crops in one year. The field left fallow in rabi is not, because it carries only the paddy.

Multiple cropping is the general term. The next sections name its kinds.

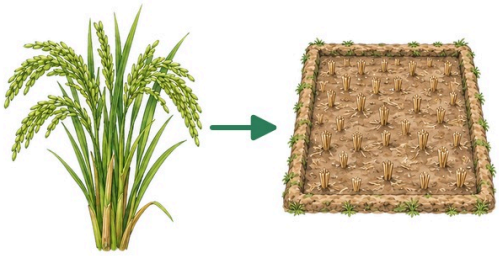
0.5 hectare



paddy, then wheat

Two crops in one year: multiple cropping

0.3 hectare



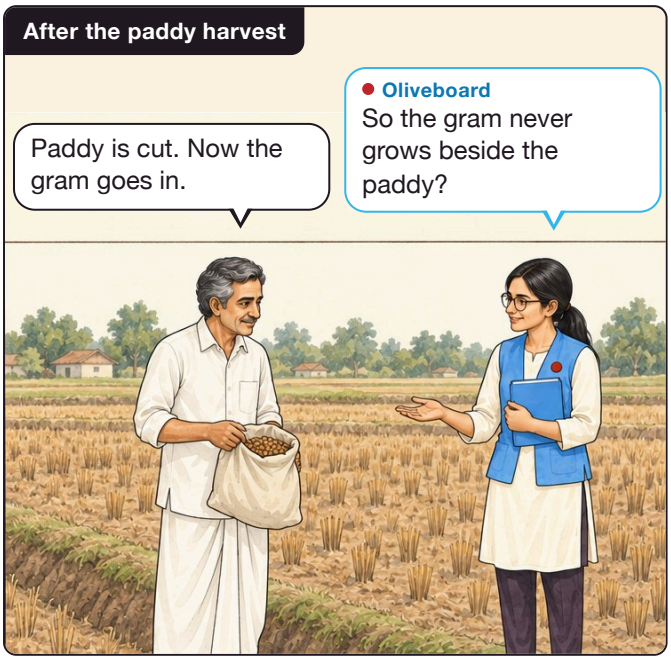
paddy, then fallow

It carries only the paddy

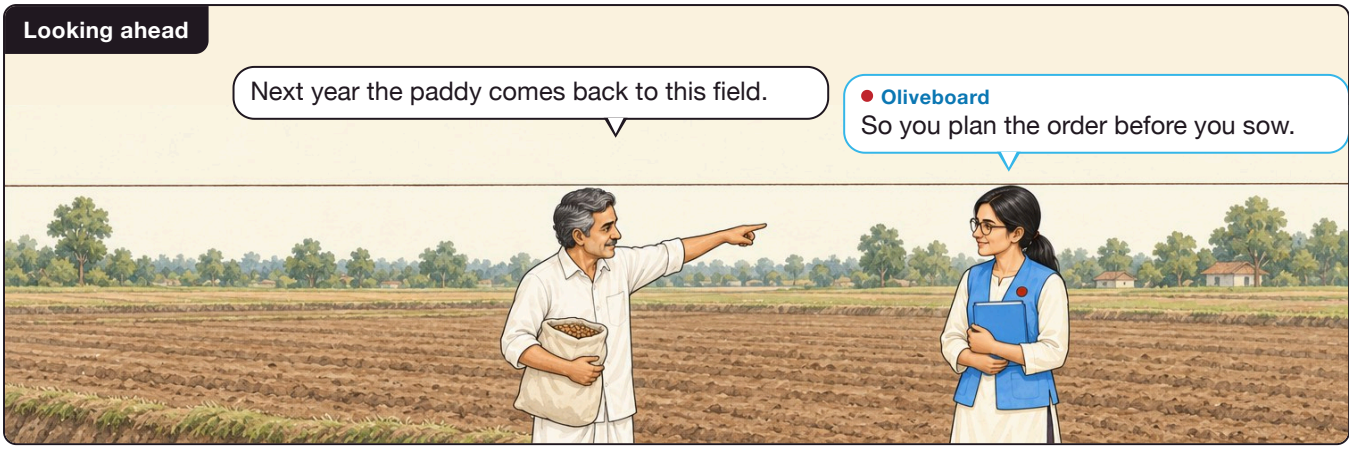
Try it 4: A field carries only sorghum in kharif and lies empty for the rest of the year. Is this multiple cropping?

Sequential cropping

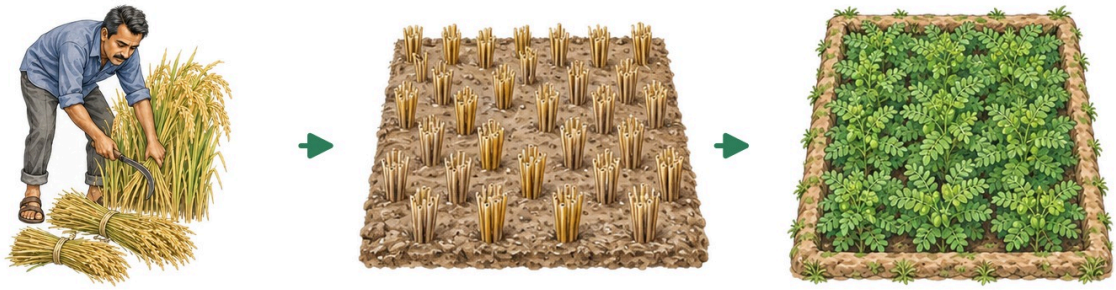
The neighbour has just cut his paddy, and Oliveboard stands with him on the bund of his field.







Sequential cropping is growing two or more crops in sequence on the same field in a farming year.



The neighbour cuts his paddy

and only then sows gram on the bare field

The two crops never stand together

The next crop is planted after the earlier crop is harvested. So the gram never stands beside the paddy, and the two crops never compete, because they never grow at once. The field is used more fully only in time. The practice is also called **sequence cropping** or non-overlapping cropping.

For example, the neighbour's paddy then gram is sequential cropping. The gram goes in after the paddy is cut, which is the test in the meaning. The Vedas already mention a first crop and a second crop.

Try it 5: Sorghum is harvested in October and chickpea is sown on the same field in November. Do the two crops compete for water while they grow?

Double, triple and quadruple cropping

Some fields carry two crops a year, and some carry three. Each count has its own name.

Double cropping, triple cropping and quadruple cropping mean growing two, three and four crops on the same land in a year, one after another.

Rice followed by cotton is double cropping. Rice, then rice, then a pulse is triple cropping. So these are counts inside sequential cropping, because the crops follow one another.

Water decides how many crops a field can carry. Where moisture is limited, as on a rainfed farm, one or two crops a year are possible. Irrigated farms can grow more than two.

Water decides how many crops a field can carry



Rainfed farm: one or two crops a year



Irrigated farms can grow more than two

The well is what allows the second crop

The length of growing period is the number of days suitable for crop growth, when the soil moisture is enough for the crop. The chapter "Weather, climate, agro-climatic zones and crop advisories" taught it. On dry land, a growing period of more than 20 weeks allows a long-duration crop or a double crop.

On the family's farm, the field with paddy then wheat is double cropping. The paddy grows on rain, and the wheat needs the well, so the well is what allows the second crop.

> *Try it 6:* A field grows rice in kharif, a second rice crop after it, and then green gram in summer. How many crops does it carry, and what is the name?

Crop rotation

The neighbour does not put gram after paddy by chance. He plans the order, and he changes the crop on that field from season to season. The chapter "Agronomy: raising a crop from field to harvest" gave its meaning, and this topic adds the reasons and rules.

Crop rotation is growing different crops on a piece of land in a pre-planned succession.



paddy gram

Crop rotation

Different crops on a piece of land in a pre-planned succession

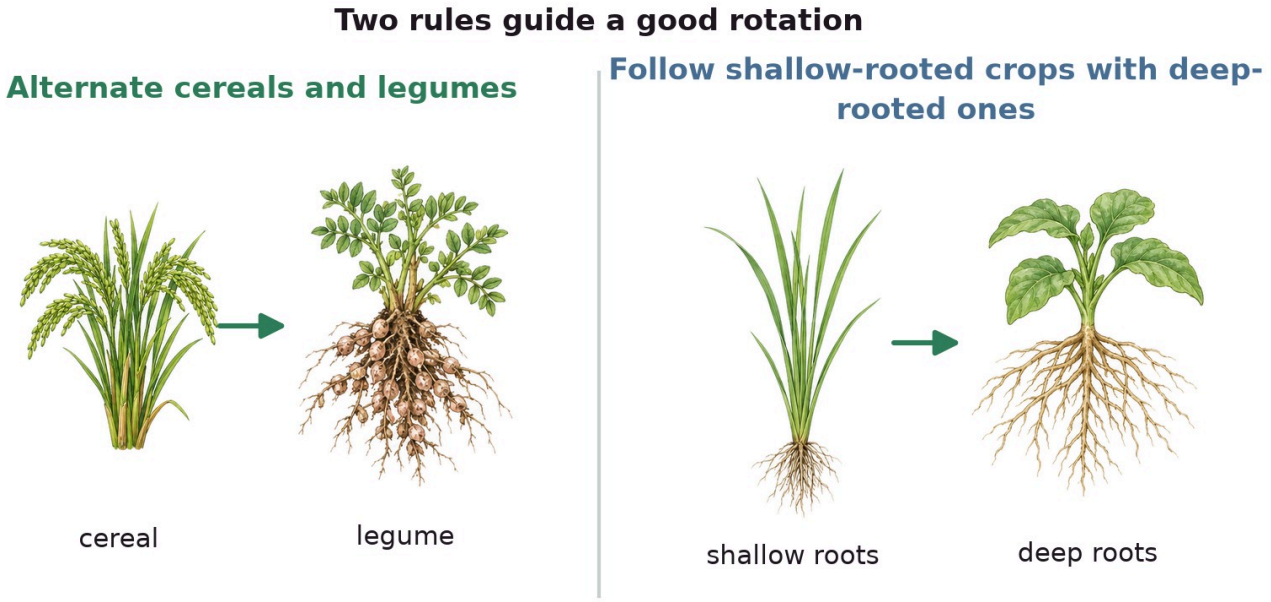
The order is decided before sowing and repeated on the same land

The order is decided before sowing and kept on the same land year after year. Inside one year, the crops of a rotation follow one another, so that year's crops are also sequential cropping. "Rotation" names the planned order over the years. The moisture and the irrigation on hand decide which crop can follow a harvest. Done properly, two or three crops a year can give good harvests.

Rotation is used for clear reasons.

- A legume in the rotation restores soil fertility. It leaves nitrogen in the soil, improves the soil, cuts pests and diseases and gives better weed control.
- Rotations reduce weed, disease and insect problems, raise soil productivity and reduce erosion.

Two rules guide a good rotation. Alternate cereals and legumes, and follow shallow-rooted crops with deep-rooted ones. The deep roots draw on water and food from a lower layer than the shallow roots. An old example is black gram, called urd, sown after rice. It helps the next rice crop through nitrogen fixation.



For example, the neighbour sows paddy then gram in that order year after year. That is a cereal followed by a legume, so it follows the first rule. The gram also feeds nitrogen to the next paddy, which is the legume reason above.

> *Try it 7:* A farmer plans to grow wheat, then wheat again, then wheat again on one field, year after year. Is this a crop rotation? Give the reason from the meaning.

Monoculture

A farmer finds that one crop pays well. He grows it on the same field every year, with no change. This is the opposite of a rotation, and it has its own name.

Monoculture is growing the same crop on the same land year after year.

Monoculture



The same crop on the same land year after year

Also called single cropping or monocropping

It is the repeated growing of the same sole crop on one piece of land. It is also called single cropping or monocropping. All three names mean the same crop over many years.

For example, plantation farming of perennial crops, such as tea, coffee, rubber and coconut, is a kind of mono-cropping. A perennial crop lives for many years, so the same crop stands on the land year after year.

Monoculture has one gain. A focus on one main crop builds specialised knowledge and the facilities for that crop. Its weakness is risk. A field with one crop has no second crop to fall back on when that crop fails, which is why farmers on dry land long preferred to mix crops.

Note that three words differ by the time span. Sole cropping is one crop alone in a field at a given time, in one season. Monoculture, single cropping and monocropping are the same crop on the same land year after year. Crop rotation changes the crop in a planned order.

Keep three words apart by the time span

Sole cropping

one crop alone in a field, in one season



Monoculture

the same crop on the same land year after year



Crop rotation

changes the crop in a planned order



Read the question for "alone in the field" or for "year after year". The sources use "single cropping" as a name for monoculture.

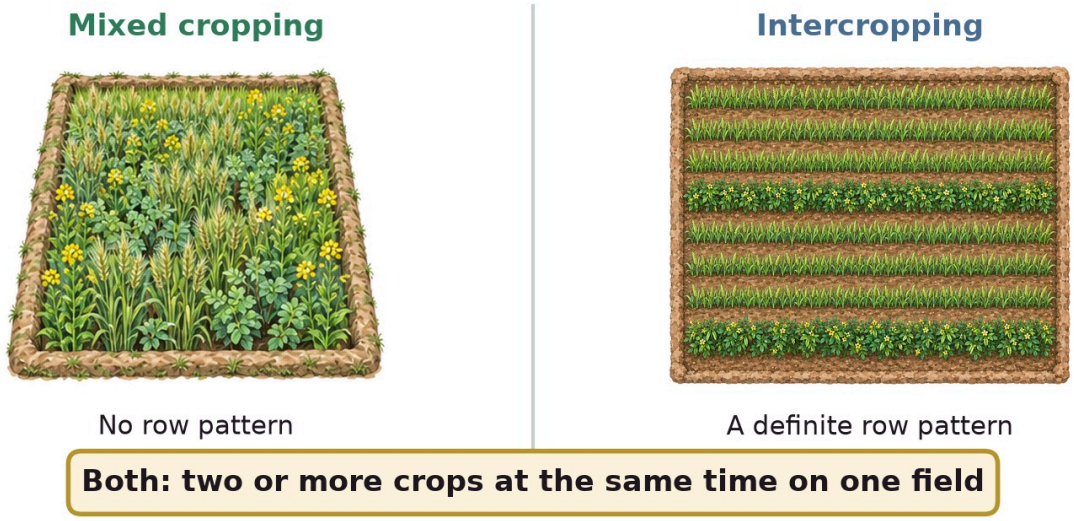
Oliveboard's exam trap

Monoculture or sole cropping? Sole cropping is one crop alone in a field at a given time. Monoculture is that same crop on the same land year after year. One season of wheat alone is sole cropping.

Try it 8: A farm grows only sugarcane on one field for ten years in a row. Is this monoculture, crop rotation or neither?

Mixed cropping

Mixed cropping is growing two or more crops at the same time on the same piece of land.



There is no distinct row arrangement and no fixed ratio. Broadcasting means scattering the seed over the field by hand.

For example, wheat with gram, wheat with mustard, and groundnut with sunflower are mixed crops. In rainfed fields, sorghum, pearl millet and cowpea are often broadcast together.

The reason is safety. Mixed cropping reduces risk and gives some insurance against the failure of one of the crops. That is why it is useful in rainfed farming. In India farmers long preferred mixed cropping on dry land to cut the risk of total crop failure.

Suppose the rain is short. The pearl millet may still give grain even when the cowpea fails. The farmer then has some harvest, which is the insurance in the meaning.



If the rain is short



the pearl millet may still give grain



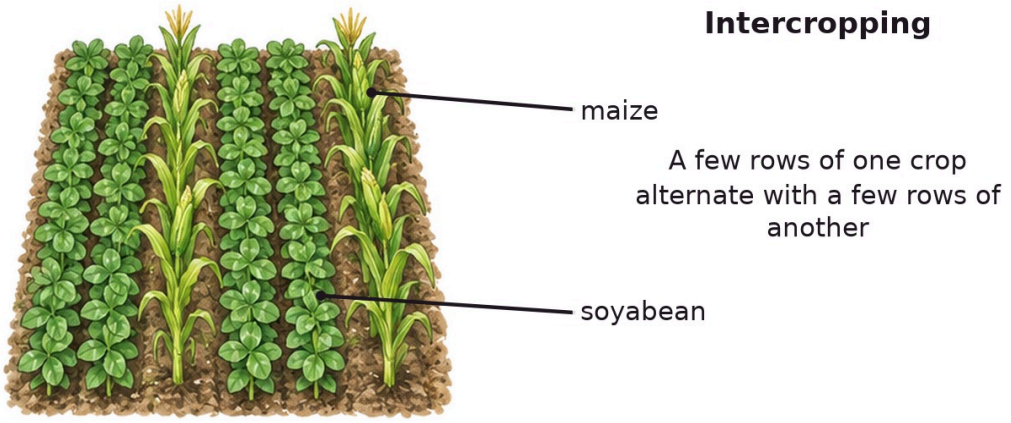
even when the cowpea fails

Mixed cropping gives some insurance against the failure of one of the crops

Try it 9: Seeds of wheat and mustard are mixed in one bag and scattered over a field. Is there a fixed row pattern? What is the practice called?

Intercropping

Intercropping is growing two or more crops at the same time on the same field in a definite pattern.



A few rows of one crop alternate with a few rows of another.

For example, a farmer sows two rows of maize, then one row of soyabean, again and again. Soyabean with maize, and finger millet with cowpea, are common intercrops.

The field is used more fully in both time and space. The crops compete with each other during all or part of their growth. Intercropping is the opposite of sole cropping.

Intercropping brings several gains.

- The crops are chosen with different nutrient needs, so the nutrients are fully used.
- Pests and diseases do not spread to all the plants in the field, so there are fewer of them.
- Light, nutrients and water are used better.
- The yield is more stable. If one crop fails, the other still gives income.

On dry land, a growing period of 14 to 20 weeks suits an intercropping system.

Oliveboard's exam trap

Mixed cropping or intercropping? Both grow two or more crops at the same time on one field. The test is the row pattern. Mixed cropping has none, and intercropping has a definite one.

Try it 10: A farmer sows one row of pigeon pea after every four rows of groundnut, across the whole field. Is this mixed cropping or intercropping?

Row intercropping and strip intercropping

Intercrops can be laid out in single rows, or in wide bands of many rows. The width of the band changes how the farmer works the field, so each layout has a name.

Row intercropping is growing two or more crops together with at least one of them in rows.

For example, maize with greengram at 1:1, one row of each, is row intercropping. Groundnut with redgram at 6:1, six rows of groundnut to one row of redgram, is another.

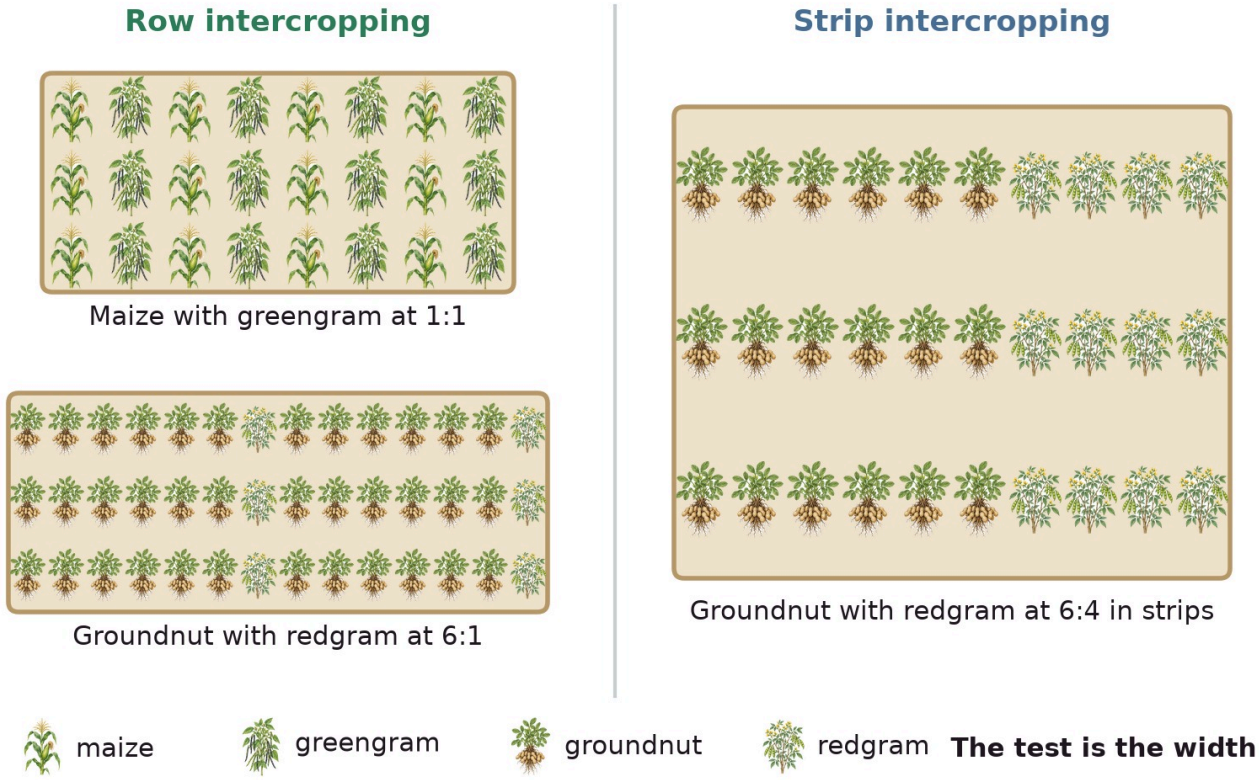
Note that the single row of redgram is what makes 6:1 row intercropping: the redgram does not form a band of its own.

Strip intercropping is growing two or more crops together in strips that are wide enough for each crop to be farmed on its own and narrow enough for the crops to interact.

For example, groundnut with redgram at 6:4 in strips is strip intercropping.

To see the difference, look at the width. In row intercropping the crops mix row by row. In strip intercropping each crop forms a band wide enough for its own work, yet the bands still affect each other.

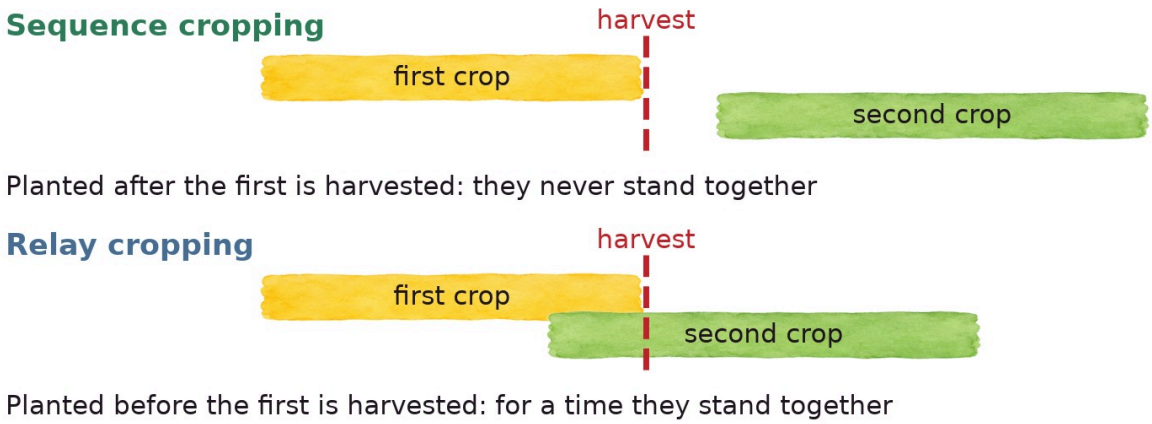
Try it 11: A field has bands of six rows of groundnut and four rows of redgram, side by side, across the field. Each band is farmed on its own. Which kind of intercropping is this?



Relay cropping

Relay cropping is planting the second crop after the first crop reaches its reproductive stage, before it is ready for harvest.

For example, in some paddy areas the farmer scatters lentil seed into the standing crop a little before the paddy is cut. The lentil sprouts in the wet soil and is already growing when the paddy is cut.

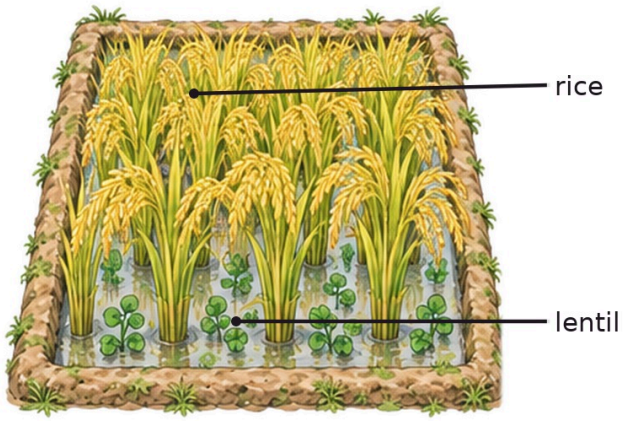


The reproductive stage is the stage of flowering and grain filling, taught in "How a crop plant lives and produces yield". Lentil sown into rice that still stands in the field is an example. Relay cropping is also called overlapping cropping, because the two crops stand together for a short time.

A well-known form is **paira cropping**, also called utera cropping. Lathyrus or lentil is sown before the rice harvest so that it uses the moisture left in the rice field. Lathyrus, also called kesari, is a pulse.

Oliveboard's exam trap

Relay or sequential? Ask when the second crop goes in. In relay cropping it goes in before the first crop is harvested, so the two stand together for a time. In sequential cropping it goes in after the harvest, as with the neighbour's gram after cut paddy.



Relay cropping

Lentil sown into rice that still stands in the field

The two crops stand together for a short time

Paira cropping: lathyrus or lentil is sown before the rice harvest

Try it 12: Lathyrus seed is scattered into a rice field two weeks before the rice is cut. Is this sequential cropping or relay cropping? Give the test.

Try it 13: An answer sheet says, "Non-overlapping cropping is the same as relay cropping." Is it right?

Ratoon cropping

The chapter "Crop classification, seasons and factors affecting production" taught the **ratoon**. After sugarcane is cut, the cane grows again from the stubble, and this regrowth is raised as a second crop.

Ratoon cropping is raising the regrowth of a crop after its harvest as a new crop. The regrowth need not be grown for grain.

Sugarcane ratoon and sorghum ratoon for fodder are examples. So ratoon cropping takes a second crop from the same planting, without sowing again.

Note that relay cropping is different. A relay crop is a new crop sown into the old one. A ratoon is the same plant growing again.



After sugarcane is cut

the cane grows again from the stubble

Ratoon: the same plant growing again

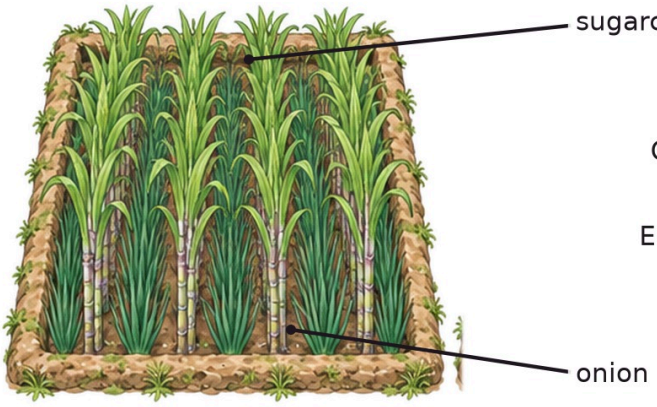
Answers to Try it

1. Yes. A cropping pattern is the sequence and arrangement of crops, or of crops and fallow, so the empty half is part of it.
2. "Paddy, then wheat" is the pattern. The straw feeding the buffalo shows the cropping system, because the meaning of a cropping system includes the crops' links with the other farm enterprises.
3. The first field. It has one variety alone in a pure stand.
4. No. Multiple cropping needs two or more crops on the same field in a year, and this field carries one.
5. No. In sequential cropping the next crop goes in after the harvest, so the two do not compete.
6. Three crops: rice, rice again, then green gram. They follow one another in one year, so it is triple cropping.
7. No. Crop rotation is different crops in a pre-planned succession. Wheat every year on the same land is monoculture.
8. Monoculture. The same crop stands on the same land year after year.
9. There is no row pattern, because mixed seed scattered by hand cannot fall in rows. It is mixed cropping.
10. Intercropping, because the crops grow at the same time in a definite row pattern.
11. Strip intercropping. Each band is wide enough to farm on its own, yet close enough for the crops to interact.
12. Relay cropping. The second crop is sown before the first is harvested.
13. No. Non-overlapping cropping is sequence cropping. Relay cropping overlaps.

How and why: crops sharing space, measuring land use, and farming systems

Companion crops and trap crops

Two crops in one field usually compete, so each gives less than it would alone. Sometimes, though, the second crop costs the main crop almost nothing, or even protects it. Each kind has a name.



Companion cropping

Onion grown with sugarcane

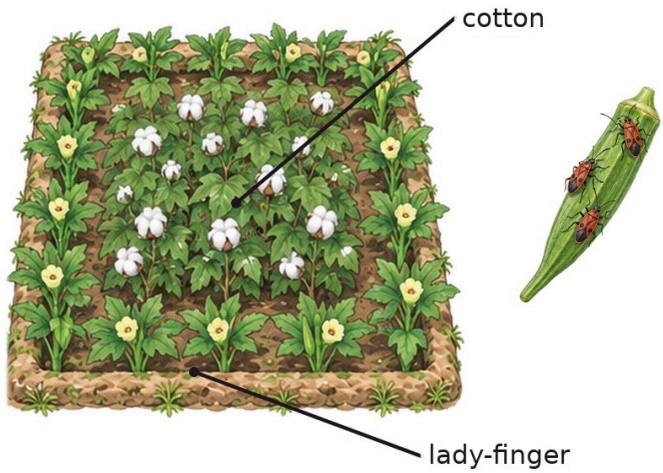
Each crop yields as much as it would in a solid planting

Companion cropping is an intercrop in which each crop yields as much as it would in a solid planting.

A solid planting is the crop grown alone. So each crop in the pair yields as much as it would alone.

For example, mustard, potato or onion grown with sugarcane are companion crops.

A **trap crop** is grown around the main cash crop to protect it from pests by drawing the pests to itself.



Trap crop

Lady-finger planted around cotton traps the cotton red bug

It draws the pests to itself and away from the main crop

For example, lady-finger planted around cotton traps the cotton red bug. Another case is castor as a border crop in a cotton field: it traps a cotton pest and also gives the farmer extra income.

To see the difference, look at the job of the second crop. With a companion crop, each crop yields as much as it would alone. A trap crop draws the pests to itself and away from the main crop.

> *Try it 14:* Rows of castor are planted around a cotton field so that a pest gathers on the castor. Is castor here a companion crop or a trap crop?

Alley cropping

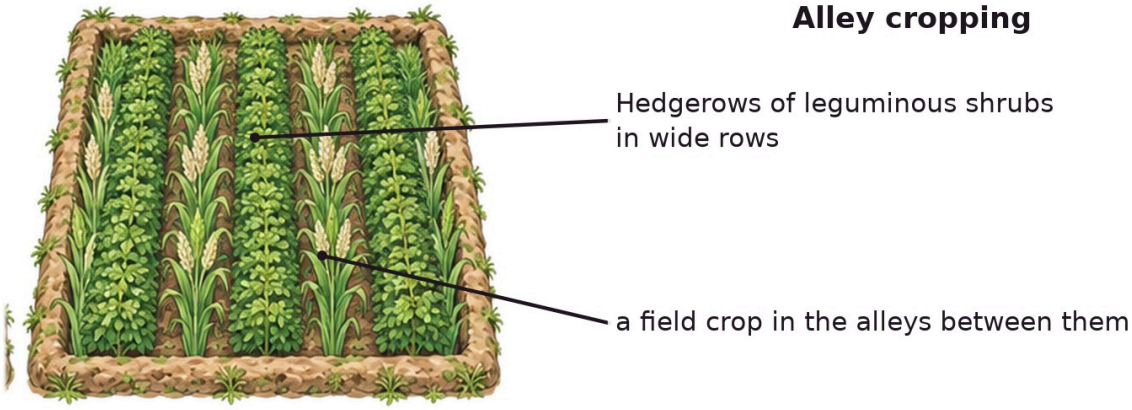
Some dry land is too poor for crops alone. A farmer there may plant rows of shrubs and grow his crop in the lanes between them. The lane layout gives the practice its name.

Alley cropping is growing perennial trees or shrubs, preferably leguminous ones, as hedgerows in wide rows, with a field crop in the alleys between them.

A hedgerow is a line of trees or shrubs kept low by cutting. A leguminous shrub belongs to the pea and bean family, so, like the legumes in a rotation, it can add nitrogen.

Alley cropping is an alternate land use for drylands that do not suit crops alone. It uses the resources better and gives more stable production. So the test is the hedgerow. A field with lines of kept trees and a crop in between is alley cropping.

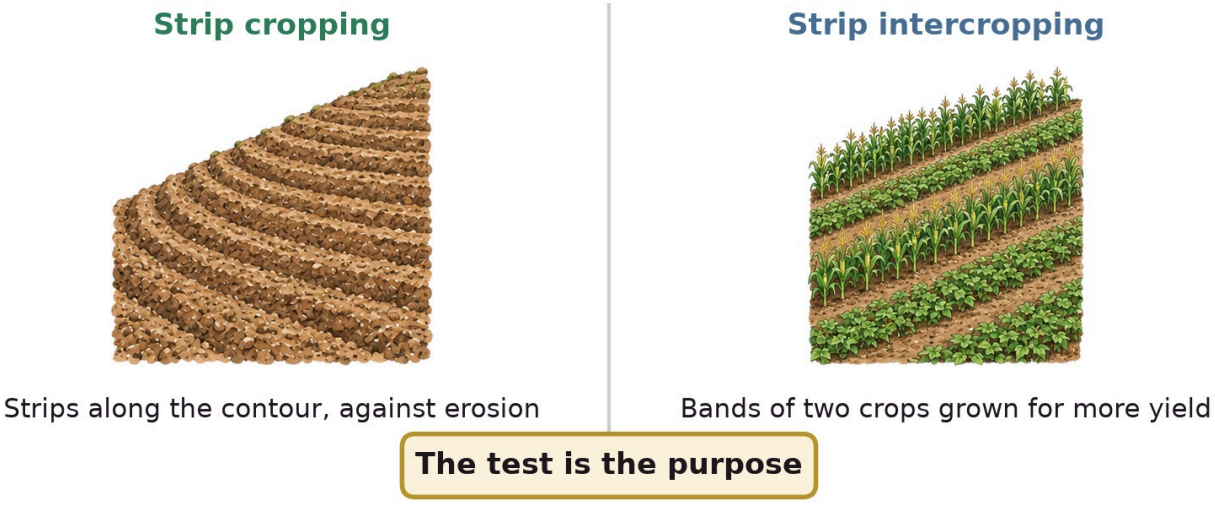
> *Try it 15:* On poor dry land, a farmer plants lines of leguminous shrubs about five metres apart, cuts them low, and grows sorghum in the lanes. What is this called?



Strip cropping and strip intercropping

The chapter "Soil erosion: kinds, causes and measurement" taught a field measure against erosion, in the topic "Soil and water conservation measures".

Strip cropping is growing field crops in narrow strips across the wind or along the contour, to prevent wind and water erosion.



The test is the purpose

It is a soil conservation measure. Note that strip intercropping, from the section "Row intercropping and strip intercropping", has a different purpose. Strips against erosion, along the contour or across the wind, are strip cropping. Bands of two crops grown for more yield are strip intercropping.

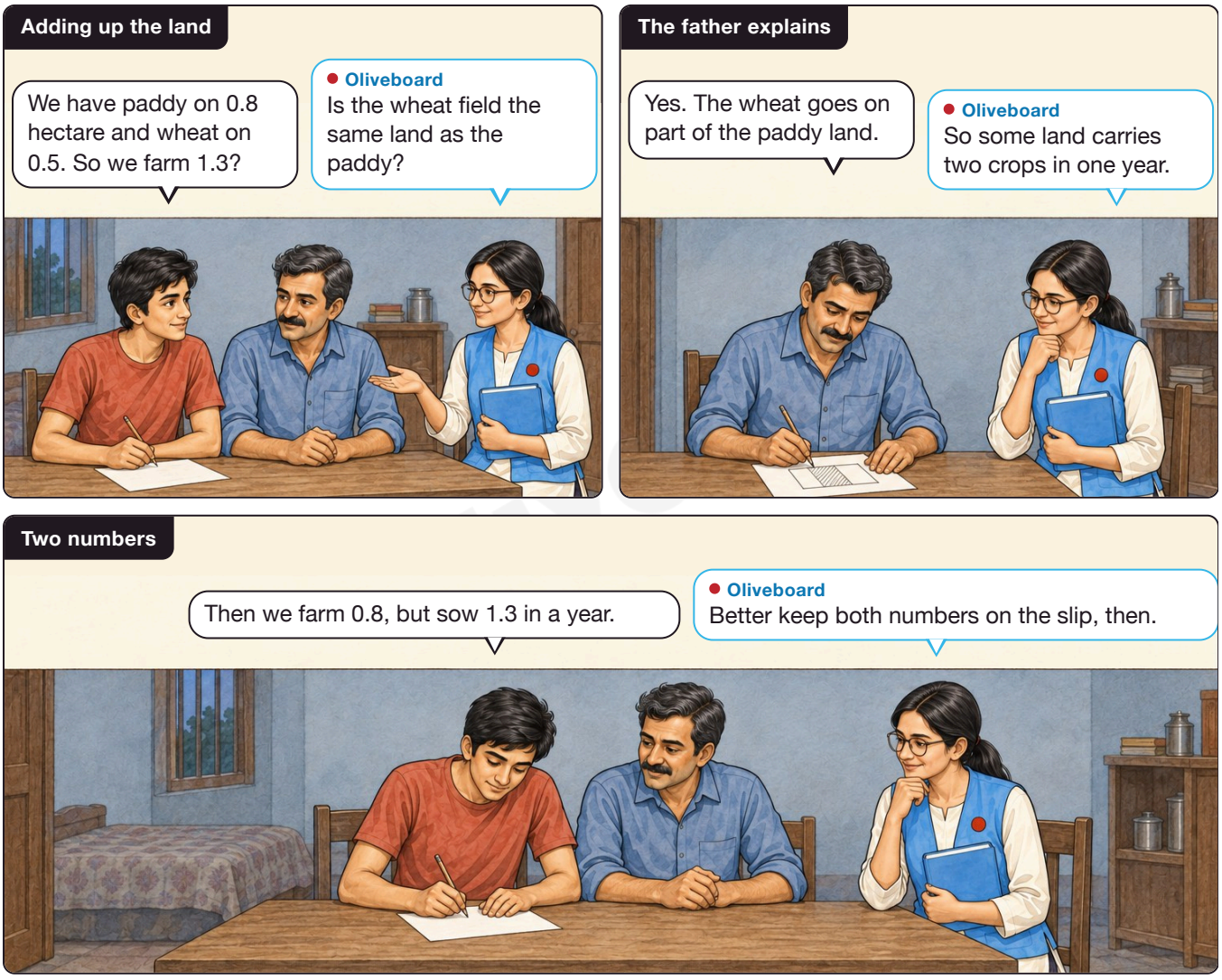
Agroforestry

Agroforestry means agriculture and forestry on the same piece of land: trees or shrubs are kept on purpose with crops or animals.

One example is rows of leguminous shrubs with a field crop in the lanes between them. So alley cropping is one form of it. The topic "Forest management, agroforestry and forest governance" mentions it again among the agroforestry systems.

Net sown area

On the family's farm, the son adds up the land on a slip of paper, with the father beside him and Oliveboard looking on.



Net sown area is the physical extent of land on which crops are sown and harvested.

Net sown area



Kharif: paddy on 0.8 hectare

+



Rabi: wheat on 0.5 hectare

The same land, counted once: 0.8 hectare

Area sown more than once in the same year is counted only once. The wheat field is the same land as the paddy: the 0.5 hectare of wheat is part of the 0.8 hectare that carried paddy. So the family's net sown area is 0.8 hectare, because the 0.5 hectare that carries both paddy and wheat is still counted once.

If someone asks how much land the family farms, the answer is 0.8 hectare. The figure 1.3 counts some land twice.

Try it 16: A farm of 2 hectares grows maize on all of it in kharif and mustard on 1.5 hectares in rabi. What is its net sown area?

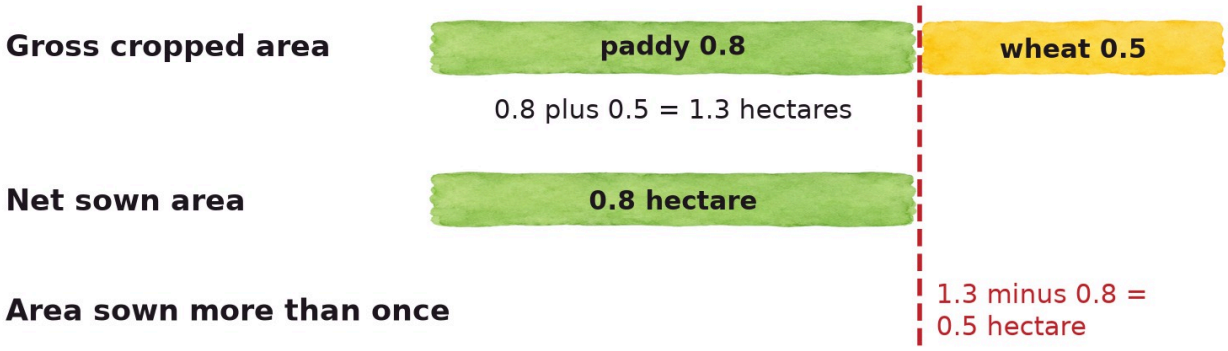
Gross cropped area

Now count each crop on the land. The family had 0.8 hectare under paddy and 0.5 hectare under wheat. The total area of all the crops in the year has a name too.

Gross cropped area counts the area as many times as there are sowings in a year.

It is also called the total cropped area. The area sown more than once in a year plus the net sown area is the gross cropped area. Here the area sown more than once is counted once for each extra sowing, so it equals the gross cropped area minus the net sown area.

On the family's farm, the gross cropped area is 0.8 plus 0.5, which is 1.3 hectares. Its area sown more than once is 1.3 minus 0.8, which is 0.5 hectare. That 0.5 hectare is the wheat field, which carried paddy before.



Read the gap with care. Gross minus net counts every extra sowing. When land is sown twice, the gap equals the area sown twice, as on the family's farm.

Suppose 1 hectare is sown three times in a year. The gross area is 3 hectares and the net area is 1, so the gap is 2 hectares on 1 hectare of land.

Try it 17: For the farm in Try it 16, find the gross cropped area and the area sown more than once.

Cropping intensity

Two farms can have the same land and yet use it very differently. One takes a single crop a year, and the other takes two crops on most of its land. One number shows how fully a farm uses its land in a year.

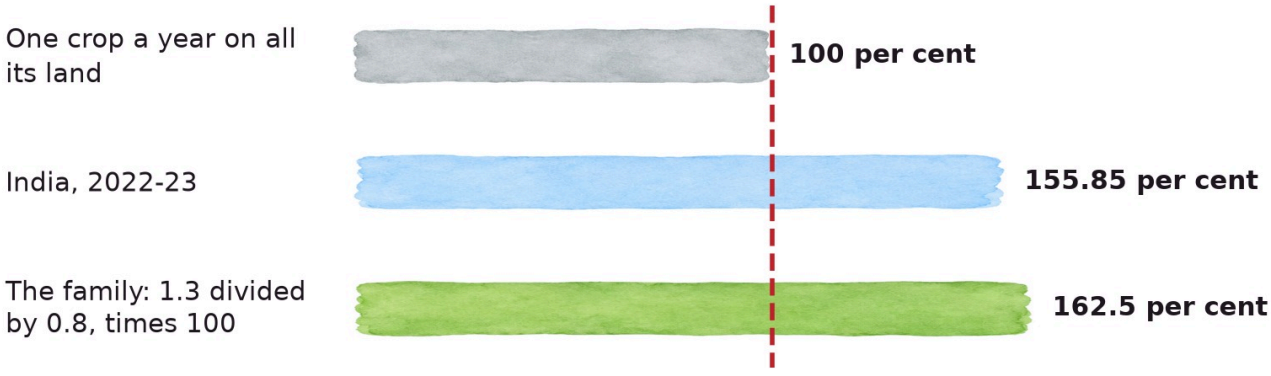
Cropping intensity is the number of crops grown on a piece of land in a year, shown as a percentage.

It is worked out from the gross cropped area and the net sown area.

Cropping intensity = (gross cropped area divided by net sown area) x 100.

On the family's farm, 1.3 divided by 0.8, times 100, gives 162.5. So its cropping intensity is 162.5 per cent.

Cropping intensity = (gross cropped area divided by net sown area) x 100



A farm with one crop a year on all its land has 100 per cent, because the gross and the net area are equal. So the figure can never fall below 100 per cent. Every sown hectare is counted at least once in the gross area. Every extra crop on the same land lifts the figure above 100.

Note that cropping intensity counts how many crops the land carries in a year. It says nothing about how much each crop yields: a farm with 162.5 per cent may still get poor harvests.

India's cropping intensity in 2022-23 was 155.85 per cent. High cropping intensity matters for India, which has little land and many workers. It uses the land fully and reduces rural unemployment.

On dry land, cropping intensity depends on the length of the growing season. A short season leaves time for one crop, and a long one for two, because water decides how many crops a field can carry.

Oliveboard's exam trap

Gross over net, or net over gross? The gross cropped area goes on top. Every sown hectare is counted at least once in the gross area, so the figure never falls below 100 per cent. The family's 1.3 over 0.8 gives 162.5 per cent.

Try it 18: Find the cropping intensity of the farm in Try it 16 and 17.

Land equivalent ratio

An intercrop of maize and greengram gives less maize than maize alone, and less greengram than greengram alone. Neither yield alone shows whether the farmer gained or lost by mixing them. A ratio that adds the two crops on one scale shows it.

The **land equivalent ratio**, written LER, is the relative land area under sole crops that would be needed to give the yields got from an intercrop.

It is worked out as the sum of the fractions of each intercrop's yield over its sole-crop yield.

Suppose maize alone gives 40 quintals a hectare and greengram alone gives 10. In the intercrop one hectare gives 30 quintals of maize and 5 of greengram. The maize fraction is 30 divided by 40, which is 0.75. The greengram fraction is 5 divided by 10, which is 0.5. The LER is 0.75 plus 0.5, which is 1.25.



Maize alone: 40 quintals a hectare



Greengram alone: 10

One hectare of intercrop:

30 quintals of maize → **30 divided by 40 = 0.75**

5 of greengram → **5 divided by 10 = 0.5**

LER = 0.75 plus 0.5 = 1.25

Sole crops would need 1.25 hectares to give what this one hectare gives

So sole crops would need 1.25 hectares to give what this one hectare of intercrop gives. When the LER is more than 1, the intercropping is beneficial. So this farmer gained by mixing the crops.

It follows from the meaning that an LER of 1 means no gain, and an LER below 1 means sole crops would do better on the same land. An LER of 1.25 says the intercrop saves land: sole crops would need a quarter more land for the same yields.

Try it 19: An intercrop gives a maize fraction of 0.6 and a pulse fraction of 0.3. What is the LER, and did the intercrop help?

Crop equivalent yield

Kilograms of maize and kilograms of greengram cannot simply be read as one crop. A farmer still wants one figure for the whole intercrop.

Crop equivalent yield is one figure for an intercrop that joins the yield of the base crop and the yield of the intercrop on one scale.

Three measures answer three different questions



Land equivalent ratio

compares land



Crop equivalent yield

compares yield



Cropping intensity

counts sowings

The base crop is the main crop of the intercrop. A successful intercrop gives higher equivalent yields and a higher cropping intensity. The intensity is higher because intercropping is a kind of multiple cropping, which makes cropping more intense in space as well as time.

To see the difference between the three measures:

- The land equivalent ratio compares land: how much land sole crops would need.
- Crop equivalent yield compares yield: the two yields joined into one figure.
- Cropping intensity counts sowings: how many crops the land carries in a year.

On the family's farm, the 162.5 per cent is built from areas only: 0.8 hectare of paddy plus 0.5 hectare of wheat, over 0.8 hectare of land. No yield enters that sum.

Crop diversification

A farm that grows only paddy loses everything in a bad paddy year. A farm that grows paddy, a pulse and vegetables, and keeps a buffalo, still has something to sell. One word names spreading a farm over more crops and animals.

Diversification in the wide sense is increasing crop and animal diversity on a farm to reduce risk.



A farm that grows only paddy

loses everything in a bad paddy year



A farm that grows paddy, a pulse and vegetables, and keeps a buffalo

still has something to sell

It works through mixed crops, agroforestry or crop and livestock systems. **Crop diversification** is its crop side: more kinds of crops on the farm.

One kind, used to adapt to climate change, is a shift to short-duration and drought-tolerant varieties. Another is a move into high-value outputs, such as fruits, vegetables, herbs, flowers and medicinal plants. The Planning Commission stressed the diversification of agriculture in its agro-climatic planning from 1988. That is the planning behind the agro-climatic regions taught in "Weather, climate, agro-climatic zones and crop advisories".

So a farm that adds a crop or an animal to lower its risk is diversifying.

To see the difference between two moves, take the family. If the family added a pulse beside its paddy and wheat, that would be crop diversification. Keeping the buffalo adds a second enterprise to the farm, and it does not add a crop.

Try it 20: A farmer who grew only wheat in rabi now grows wheat on half his land and vegetables on the other half. What is this change called, and what is its main aim?

Crop diversification in India

Since 2013-14 the Crop Diversification Programme has worked in Haryana, Punjab and western Uttar Pradesh, the first Green Revolution states. It is a sub-scheme of the Pradhan Mantri Rashtriya Krishi Vikas Yojana (PM-RKVY). It moves land from rice to pulses, oilseeds, coarse and nutri cereals and cotton.

The programme shows farmers better ways to grow these other crops, and it uses legume crops to restore soil fertility. It helps in four ways: demonstrations of the other crops, farm machines and value addition, work suited to each site, and awareness and training. For example, a pulse demonstration gets Rs 10,000 a hectare. From 2015-16 the programme also helps the main tobacco-growing states replace tobacco.

Two sets of figures show the change.

- From 2013-14 to 2024-25, demonstrations of the other crops covered 6,96,047 hectares in all.
- From 2018-19 to 2024-25, the area under food grains rose by 127.72 lakh hectares, millets by 5.13 lakh hectares and oilseeds by 56.46 lakh hectares.

Other missions support one group of crops each.

- Coarse and nutri cereals (Shree Anna): the National Food Security and Nutrition Mission.
- Pulses: the Mission for Aatmanirbharata on Pulses.
- Oilseeds: the National Mission on Edible Oils (Oilseeds).
- Horticulture crops: the Mission for Integrated Development of Horticulture.

The Prime Minister Dhan-Dhaanya Krishi Yojana covers 100 selected districts, and crop diversification is one of its main objectives. States run their own schemes too. Haryana has run "Mera Pani Meri Virasat" since 2020. It moves paddy land to other high-value crops, because the groundwater is falling.

Crop rotation versus intercropping

The sections "Crop rotation" and "Intercropping" gave both words. The exam often asks for the one difference between them.

Two principles lie under every cropping system. One is growing crops together in a mixture, as in intercropping. The other is growing crops one after another, as in sequential cropping.

Two principles lie under every cropping system



Growing crops together in a mixture

as in intercropping



Growing crops one after another

as in sequential cropping

Intercropping grows the crops at the same time, in a definite row pattern. A rotation grows them one after another. A farm's cropping system may use either principle or both.

So the test has two steps. If the crops stand together in rows, it is intercropping. If they stand together with no row pattern, it is mixed cropping. If one follows the other in a planned order, it is a rotation.

For example, a farm can do both: maize with soyabean in kharif rows, then wheat in rabi.

Most forms in "The basics" are kinds of multiple cropping. Intercropping, relay cropping, sequential cropping and ratoon cropping all come under this general term. Mixed cropping is also a form of it. Sole cropping is not one of them, because it is one crop alone in a field at a given time. The same farm can still be under multiple cropping over the year.

On the family's farm, the 0.5 hectare carries paddy in kharif and then sole wheat in rabi. Each season's crop stands alone, yet the field carries two crops in the year.

Multiple cropping



Intercropping



Relay cropping



Sequential cropping



Ratoon cropping



Sole cropping is not one of them

Try it 21: Maize and soyabean grow in alternate rows in kharif, and then wheat follows in rabi. Which part is intercropping, and which part is a sequence?

Farming system and integrated farming system

The family does not only grow crops. It keeps a buffalo, which eats the paddy straw. The buffalo's dung goes back to the field as manure. The chapter "Agriculture: meaning, scope and branches" named the whole linked farm, and this topic adds the word for a farm built on such links on purpose.

A **farming system** is a set of working units, such as crops, livestock, processing, investment and marketing, that interact through their joint use of inputs.

So it is wider than the cropping system: it includes the animals and the farm's other activities as well as the crops.

An **integrated farming system**, written IFS, joins two or more enterprises suited to each farm's resources.

The enterprises can be crops, dairy, piggery, fishery, poultry or bee keeping. It is a mix of enterprises with cropping, in which the wastes are recycled to give extra income. The recycling of by-products and wastes is its core principle.

The family's farm shows this link on a small scale. The straw goes to the buffalo, and the dung goes back to the field, so a waste from one enterprise becomes an input for the other. The family does not buy that fodder or that manure. The milk the family sells brings money in between harvests.



1. The straw goes to the buffalo
2. Milk: 5 litres a day; 4 sold, 1 drunk at home
3. The dung goes back to the field

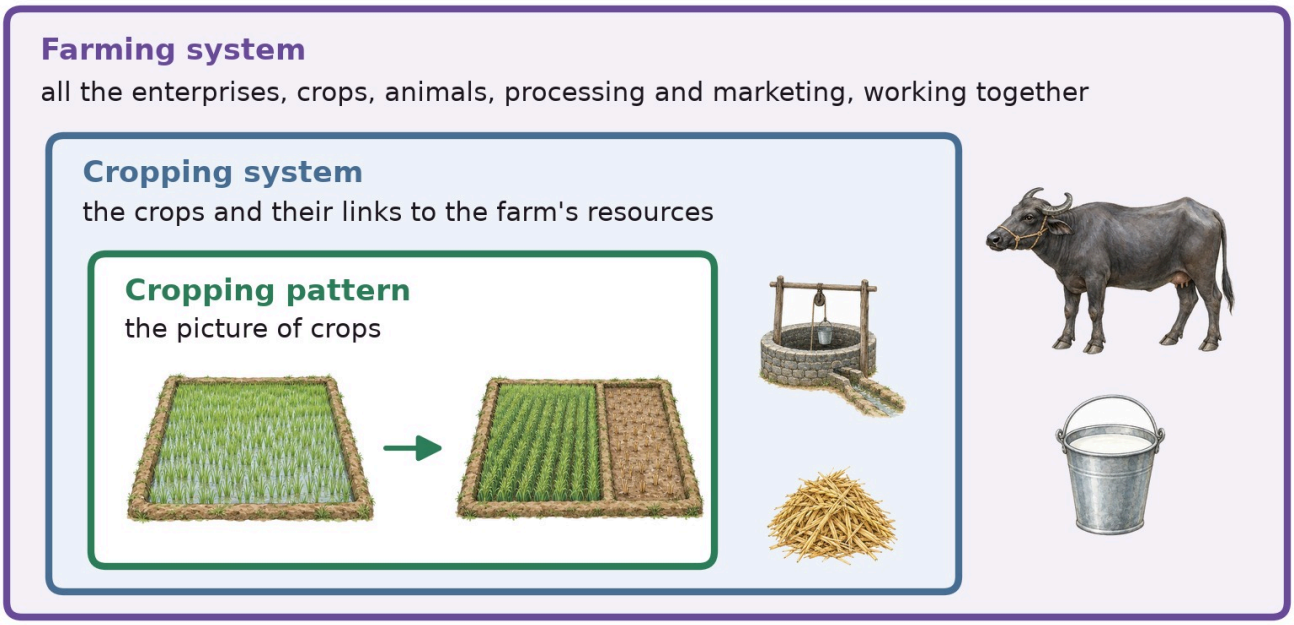
A waste from one enterprise becomes an input for the other

IFS has clear benefits.

- It suits small and marginal farmers.
- The recycling reduces pollution.
- It brings money in round the year.

A crop, goat and agroforestry mix is one dry land based farming system. The Rainfed Area Development scheme promotes IFS models made by the Indian Council of Agricultural Research for each agro-climatic zone.

Note the order of three words. A cropping pattern is the picture of crops. A cropping system is the crops and their links to the farm's resources. A farming system is all the enterprises, crops, animals, processing and marketing, working together.



So the straw that feeds the buffalo is a link of the cropping system to another farm enterprise. The whole farm of crops, buffalo and recycled dung, seen as one set of enterprises, is the farming system.

Oliveboard's exam trap

Cropping system or farming system? The cropping system is the crops and their links to the farm's resources. The farming system takes in all the enterprises, crops, animals, processing and marketing, working together. The straw link belongs to the cropping system. The paddy, the wheat and the buffalo seen together as enterprises make the farming system.

Try it 22: A farm grows paddy, keeps fish in a pond, and puts the pond silt and the fish waste on the paddy field. Which word fits best: cropping system or integrated farming system? Give the reason.

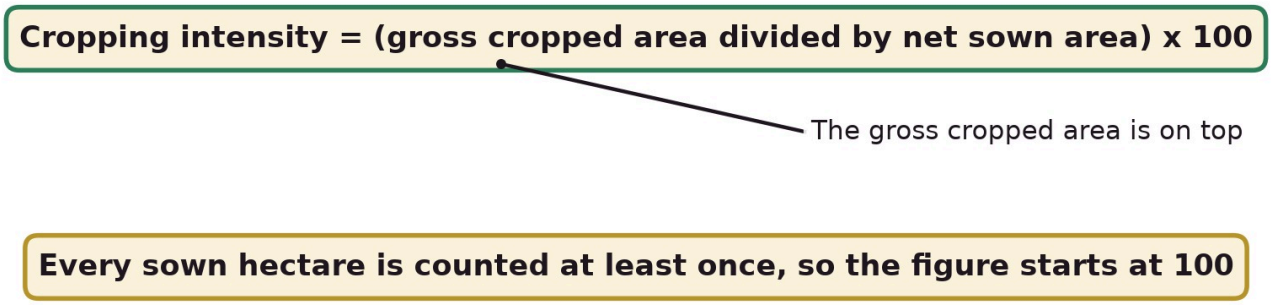
Answers to Try it

14. A trap crop. It draws the pest away from the cotton.
15. It is alley cropping, because leguminous shrubs stand as hedgerows with a crop in the alleys.
16. 2 hectares. The 1.5 hectares sown twice are counted once.
17. The gross cropped area is 2 plus 1.5, which is 3.5 hectares. The area sown more than once is 3.5 minus 2, which is 1.5 hectares.
18. 3.5 divided by 2, times 100, is 175 per cent.
19. The LER is 0.6 plus 0.3, which is 0.9. It is below 1, so sole crops would have done better.

20. Crop diversification. Its aim is to reduce risk.
21. The maize and soyabean rows are intercropping. Wheat after them is a sequence, and a planned one is a rotation.
22. Integrated farming system. Two enterprises, crops and fish, are joined, and the waste of one is recycled into the other. The same kind of link on the family's farm, straw to buffalo and dung to field, is named an integrated farming system when the farm is planned as joined enterprises with recycling.

Exam edge

Oliveboard's exam traps



- **Cropping pattern or cropping system?** The pattern is the sequence and layout of crops and fallow. The system adds how they work with the farm's resources, enterprises and technology. Paddy then wheat is a pattern, and the straw feeding the buffalo is part of the cropping system.
- **Cropping system or farming system?** The cropping system is the crops and their links to the farm's resources. The farming system is all the enterprises working together. Paddy, wheat and the buffalo seen together as enterprises make a farming system.
- **Mixed cropping or intercropping?** Mixed cropping has no row pattern. Intercropping has a definite row pattern. Two rows of maize to one of soyabean is intercropping.
- **Row or strip intercropping?** Row intercropping mixes the crops row by row, as maize with greengram at 1:1. Strip intercropping uses bands wide enough to farm separately, as groundnut with redgram at 6:4.
- **Strip intercropping or strip cropping?** Strip intercropping aims at more yield from two crops. Strip cropping aims to stop erosion, with strips along the contour or across the wind.
- **Relay or sequential cropping?** Relay: the second crop goes in before the first is harvested, as lentil into standing rice. Sequential: after the harvest, as gram after cut paddy.



- **Relay or ratoon cropping?** Relay sows a new crop into the old one. Ratoon grows the same plant again after harvest, as sugarcane regrowth from stubble.
- **Crop rotation or monoculture?** Rotation changes the crop in a planned order. Monoculture keeps the same crop year after year, as sugarcane every year.
- **Sole cropping or monoculture?** Sole cropping is one crop alone in a field. Monoculture is that same crop repeated year after year.
- **Crop rotation or intercropping?** Rotation grows crops one after another, in a planned order that repeats. Intercropping grows them at the same time, in rows. Soyabean then wheat, every year as planned, is a rotation and also sequential.
- **Net sown area or gross cropped area?** Net counts land sown more than once only once. Gross counts it once for each sowing. The family has net 0.8 hectare and gross 1.3 hectares.
- **Land equivalent ratio or crop equivalent yield?** The ratio compares land: the land sole crops would need. The equivalent yield compares yield: both yields joined on one scale, as one figure. An LER of 1.25 means sole crops need 1.25 hectares.
- **Companion crop or trap crop?** A companion adds a yield, and the main crop's yield does not fall, as onion in sugarcane. A trap crop draws pests away, as castor around cotton.

Wrong options that look right

Each line gives a wrong statement that exam takers often choose.

- "Cropping intensity is net sown area divided by gross cropped area, times 100." Wrong. The gross cropped area is on top.
- "A cropping intensity of 80 per cent is possible." Wrong. Every sown hectare is counted at least once in the gross area, so the figure starts at 100.
- "Mixed cropping and intercropping are the same." Wrong. Intercropping has a definite row pattern, and mixed cropping has none.
- "In relay cropping the second crop is sown after the first is harvested." Wrong. That is sequential cropping. Relay sowing comes before the harvest.
- "Sequence cropping is a kind of relay cropping." Wrong. Sequence cropping is non-overlapping, and relay cropping overlaps.
- "An LER of 1.2 means the intercrop gave 1.2 times the yield of each crop alone." Wrong. It means sole crops would need 1.2 hectares to match one hectare of the intercrop.

- "Crop rotation means growing the same crop every year." Wrong. That is monoculture. Rotation changes the crop in a planned order.
- "Strip cropping is a form of intercropping for more yield." Wrong. Strip cropping is a measure against wind and water erosion.
- "An integrated farming system suits only large farms." Wrong. It suits small and marginal farmers.
- "Ratoon cropping means sowing a fresh crop into a standing one." Wrong. That is relay cropping. A ratoon is regrowth after harvest.

Answer-writing practice

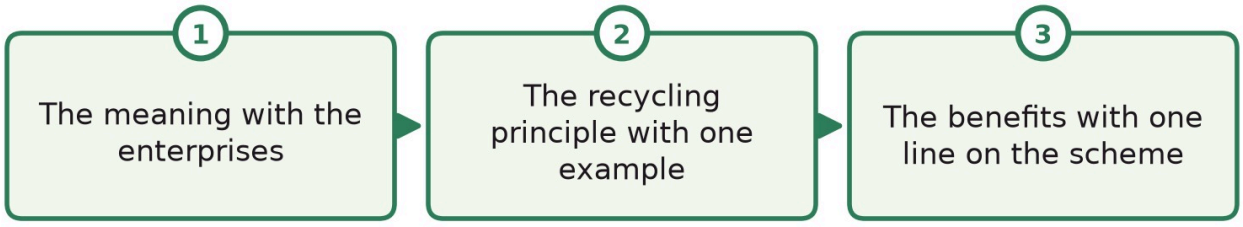
In the exam

- The ESI and ARD test gives 30 minutes of objective questions. Then the descriptive test starts by itself and runs for 90 minutes, with no going back.
- 6 questions come on screen, one at a time. You attempt 4: two of 15 marks and two of 10 marks. If you answer more than 4, only the first 4 are marked.
- You type on a keyboard, in English or Hindi. The past questions set 600 words for 15 marks and 400 words for 10 marks.
- Press Enter straight after the last word to start a new line. Space then Enter does not start one, and many presses in a row count as one.
- This is a time plan you can follow. About 6 minutes go to reading all 6 questions and choosing. About 25 minutes go to each 15-mark answer, and about 17 minutes to each 10-mark answer. 600 words in 25 minutes is about 24 words a minute.

Past question: 2025, 10 marks, about 400 words

"What is crop diversification? Discuss its benefits, for farmers and agricultural sustainability in India."

Read it. It asks three things: what crop diversification is, its benefits for farmers, its benefits for agricultural sustainability. Each asked thing becomes one heading you type.



Plan before you type (about 2 minutes).

- Opening, 2 or 3 lines: the definition in "Crop diversification": more crop and animal diversity on a farm, to reduce risk. Crop diversification is its crop side. Ways: mixed crops, agroforestry, crop and livestock systems.

- Heading 1, benefits for farmers: lower risk. Insurance against the failure of one crop ("Mixed cropping"). More stable yield, income from the other crop ("Intercropping"). High-value outputs: fruits, vegetables, herbs, flowers, medicinal plants. Money round the year from joined enterprises ("Farming system and integrated farming system"). In India, the Crop Diversification Programme helps farmers move from rice to pulses, oilseeds, cereals and cotton, with demonstrations, machines and training ("Crop diversification in India"). Other missions back cereals, pulses, oilseeds and horticulture.
- Heading 2, benefits for sustainability: a legume in the rotation restores soil fertility, leaves nitrogen ("Crop rotation"). Fewer weed, disease and insect problems, less erosion. Light, nutrients and water used better. Short-duration, drought-tolerant varieties to adapt to climate change. Recycling cuts pollution. Legume crops in the Crop Diversification Programme restore soil fertility ("Crop diversification in India"). Haryana moves paddy land to other crops because the groundwater is falling.
- Closing, 1 or 2 lines: the Planning Commission stressed diversification in agro-climatic planning from 1988. From 2013-14 to 2024-25, demonstrations of other crops covered 6,96,047 hectares; from 2018-19 to 2024-25, oilseed area rose by 56.46 lakh hectares. The opposite, monoculture, has no second crop to fall back on ("Monoculture").
- Words: opening 60, farmers 150, sustainability 130, closing 60.

Type it. Type "Benefits for farmers" on its own line and press Enter straight after the last word. Do the same for "Benefits for sustainability". Key in the benefits as short numbered lines. Show the link as a typed chain, such as "more crops -> lower risk -> steady income". By about 8 minutes, aim for about 200 words on screen.

Check before the next question (about 1 minute). Both benefit headings are on screen. The opening defines crop diversification. The year reads 1988, and the area reads 6,96,047 hectares, as in the note. The closing line is there. The count is near 400 words.

This chapter's other past question (2024, 10 marks) and how to type its answer are in the second part of this chapter, "Dryland agriculture and managing rain failure", under "Answer-writing practice".

Check yourself

1. A district has a net sown area of 100 thousand hectares and a gross cropped area of 150 thousand hectares. What is its cropping intensity?

   - A. 66.7 per cent
   - B. 250 per cent
   - C. 150 per cent
   - D. 50 per cent
   - E. 100 per cent

   Answer: C. Taught in the section "Cropping intensity". 150 divided by 100, times 100, is 150 per cent. A puts the net area on top. B adds the two areas. D (50 per cent) is gross minus net over net, the share of land sown more than once. E would need the gross and the net area to be equal, and here the gross area is larger.

2. A farmer sows lentil seed into a standing rice crop a little before the rice is harvested, so the lentil uses the moisture left in the field. What is this practice called?

   - A. Sequential cropping
   - B. Relay cropping
   - C. Mixed cropping
   - D. Alley cropping
   - E. Ratoon cropping

   Answer: B. Taught in the section "Relay cropping". The second crop goes in before the first is harvested, and paira cropping uses the leftover moisture in this way. A is wrong, because a sequential crop goes in after the harvest. C has both crops sown together, and D needs hedgerows. E is regrowth of the same plant after harvest, and lentil is a new crop.

3. Two crops grow at the same time on the same field in both mixed cropping and intercropping. What sets intercropping apart?

   - A. The crops grow in the same season.
   - B. Two crops are taken in one year.
   - C. Animals are kept with the crops.
   - D. The seeds of both crops are mixed and scattered together.
   - E. The crops grow in a definite row pattern.

   Answer: E. Taught in the section "Intercropping". Intercropping has a definite row pattern, and mixed cropping has none. A is true of both. B describes multiple cropping. C describes a farming system. D describes mixed cropping, where the seed is broadcast with no rows.

4. Which idea lies at the core of an integrated farming system?

   - A. The recycling of by-products and wastes between enterprises
   - B. One enterprise run on a large scale
   - C. Growing only one crop on the whole farm
   - D. Buying all inputs from outside the farm
   - E. Keeping the crops and the animals on separate farms

   Answer: A. Taught in the section "Farming system and integrated farming system". Resource recycling is the core principle of IFS. B and C go against the joining of two or more enterprises. D goes against the recycling. E breaks the link, because the waste of one enterprise must reach the other.

5. An intercrop of two crops has a land equivalent ratio of 1.3. What does this mean?

   - A. Each crop gave 1.3 times its sole-crop yield.
   - B. The intercrop gave 30 per cent less than sole crops.
   - C. The farm took 1.3 crops in the year.
   - D. Sole crops would need 1.3 hectares to give what one hectare of the intercrop gives.
   - E. The intercrop gave no gain over sole crops.

Answer: D. Taught in the section "Land equivalent ratio". The ratio is the land under sole crops needed to match the intercrop. It is above 1, so the intercrop helped. A misreads it as a yield, and B reverses it. C confuses it with cropping intensity. E fits an LER of 1, and this ratio is above 1.

6. Which of these is not a form of multiple cropping?

   - A. Intercropping
   - B. Relay cropping
   - C. Ratoon cropping
   - D. Sequential cropping
   - E. Sole cropping

   Answer: E. Taught in the section "Crop rotation versus intercropping". Intercropping, relay, sequential and ratoon cropping come under multiple cropping. Mixed cropping does too. Sole cropping is one crop alone in a pure stand.

7. A farmer grows the same crop on the same field every year for many years. What is this called?

   - A. Crop rotation
   - B. Monoculture
   - C. Crop diversification
   - D. Strip cropping
   - E. Relay cropping

   Answer: B. Taught in the section "Monoculture". The same crop on the same land year after year is monoculture. A changes the crop in a planned order. C adds crops to cut risk. D is a measure against erosion. E sows a new crop into a standing one.

Next

The topic "Dryland agriculture and managing rain failure" in this chapter turns to farms that depend only on rain. It teaches dryland agriculture and what a farmer does when the rain fails. It uses the words of this topic, above all cropping intensity, mixed cropping and intercropping.