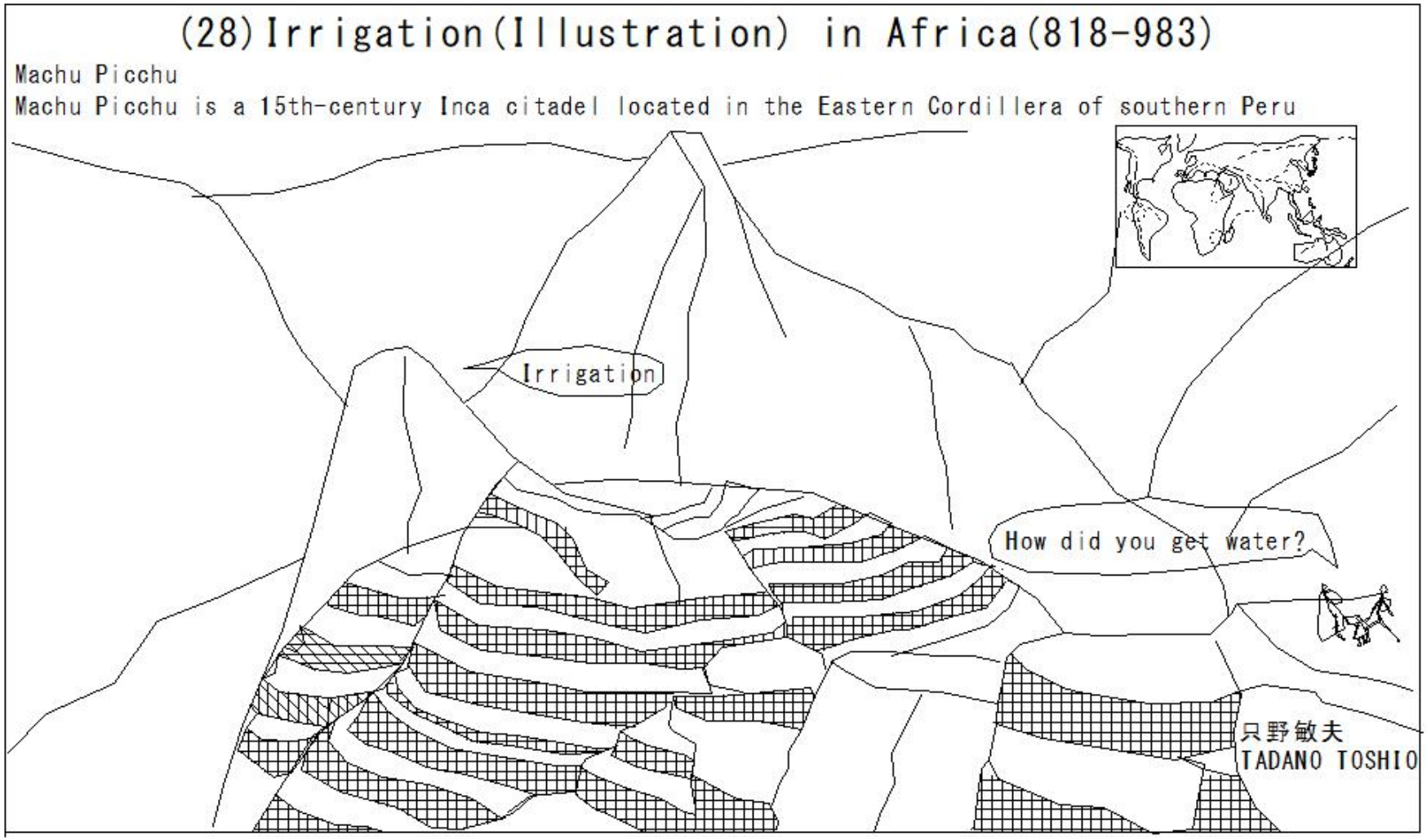
(28)Irrigation(Illustration) in Africa(818-983)



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只野敏夫
Tadano Toshio

(I818)Agricultural Water Use	Agricultural Water Use
(I819)Irrigation	Irrigation
(I820)Soil Moisture	Soil Moisture
(I821)Irrigation and drainage effects	Irrigation and drainage effects
(I822)Rice Field Irrigation Water	Rice Field Irrigation Water
(I823)Field Irrigation Water	Field Irrigation Water
(I824)Facilities for Horticulture Water	Facilities for Horticulture Water
(I825)Livestock water	Livestock water
(I826)Water requirement for field irrigation	Water requirement for field irrigation
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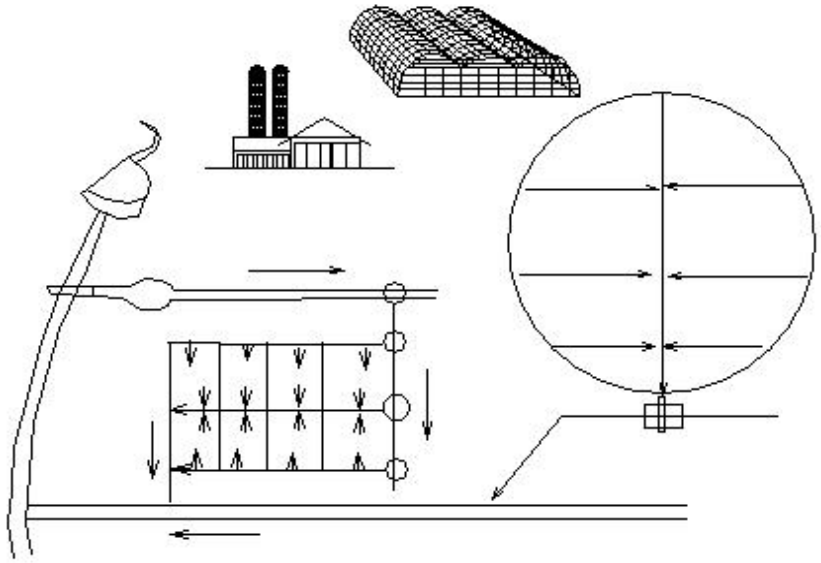
(I818) Agricultural Water Use

(I818) Agricultural Water Use

Agricultural Water Use

① Supplying water necessary for agriculture, draining it, and maintaining water facilities

② Securing the water necessary for crop growth and removing excess water



Layout of farmland and various facilities

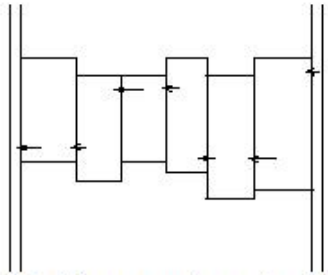
I334
1413

(I819) Irrigation

Irrigation

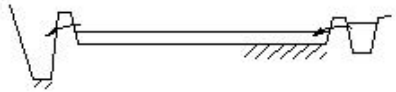
① Artificially supplying the water necessary for crop growth without relying on natural rainfall

② Transporting water to farmland from rivers, lakes, groundwater, etc., or draining excess water



Rice field crossing irrigation

I34



Continuous irrigation

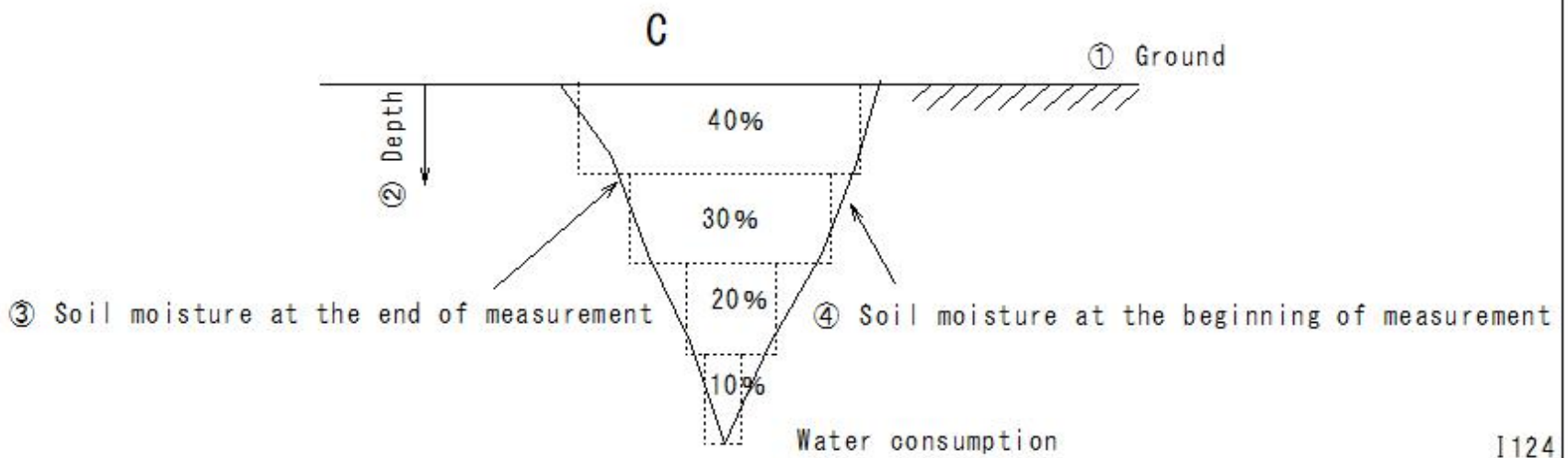
I35

(I820) Soil Moisture

(I820) Soil Moisture

Soil Moisture

① The amount of water in the soil
② It is expressed by the moisture content and water potential of the soil.
③ Soil moisture has a significant effect on plant growth and soil properties,
so proper management is important



I124

(I821)Irrigation and drainage effects

(I821) Irrigation and drainage effects

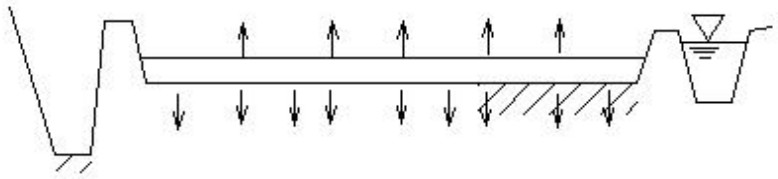
Irrigation and drainage

① Supplying the water needed for crop cultivation to farmland

② Removing excess water

Objectives:

- Promoting crop growth.
- Increasing yields.
- Preventing disasters (floods, wetland damage).
- Improved agricultural productivity



Flushing irrigation

Paddy field irrigation methods

(I822) Rice Field Irrigation Water

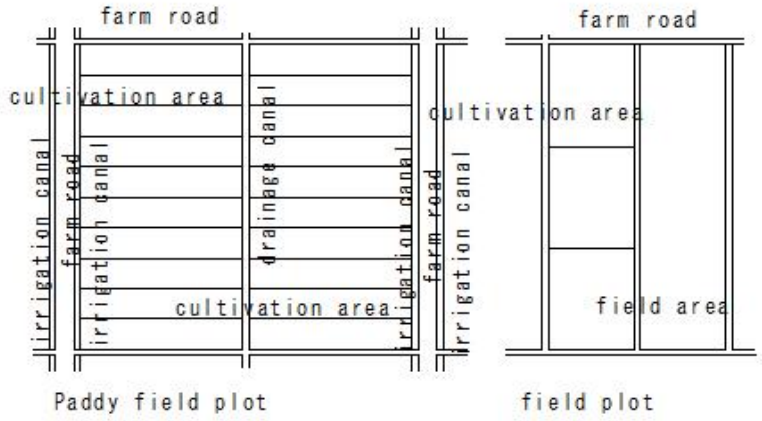
(I822) Rice Field Irrigation Water

Agricultural Water

Rice Field Irrigation Water

① Water is drawn from dams and rivers, etc., and poured into the rice fields through irrigation channels to supply water to rice paddies.

② In rice paddies, water is stored on the entire surface to ensure stable water supply for rice growth.



Farmland block

I62

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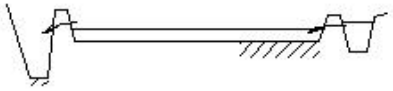


Continuous irrigation

Paddy field irrigation methods

I35

(I823)Field Irrigation Water

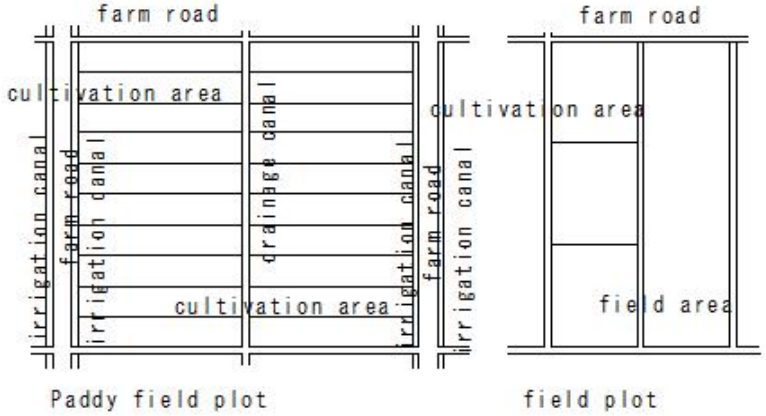
(I823)Field Irrigation Water

Agricultural Water

Field Irrigation Water

① Water supplied to ordinary fields, orchards, pasture fields, etc. to maintain and improve the growing environment for field crops.

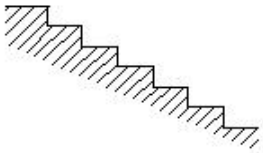
② Sprinkler methods such as sprinklers and reel machines are used.



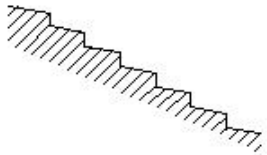
Farmland block

I62
E463

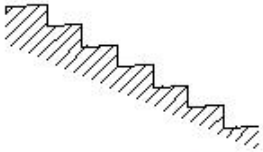
horizontal bench terrace field



sloping bench terraced field

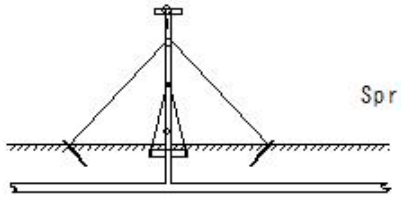


reverse bench slope terrace field



Bench terraced fields

E469
I704



Sprinkler

I160

(I824)Facilities for Horticulture Water

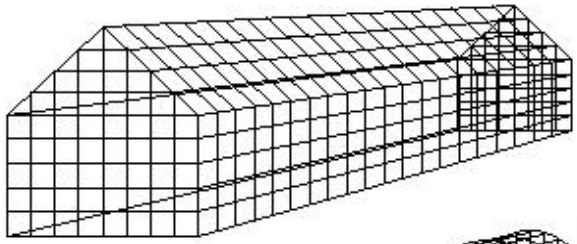
(I824)Facilities for Horticulture Water

Agricultural Water

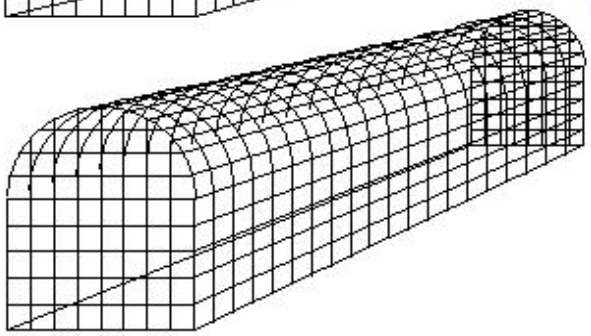
Facilities for Horticulture Water

① Water required for growing crops (vegetables, fruits, etc.) in facilities such as greenhouses and greenhouses.

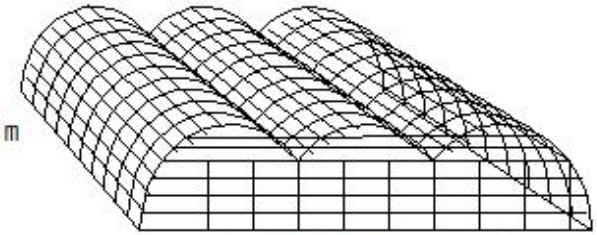
② Water not only provides the hydration required for cultivation, but also includes water that is useful for cultivation management, such as preventing frost damage and pest control.



Made of glass



Made of plastic film



Plastic greenhouse

I297

Greenhouse

I13

(I825)Livestock water

(I825)Livestock water

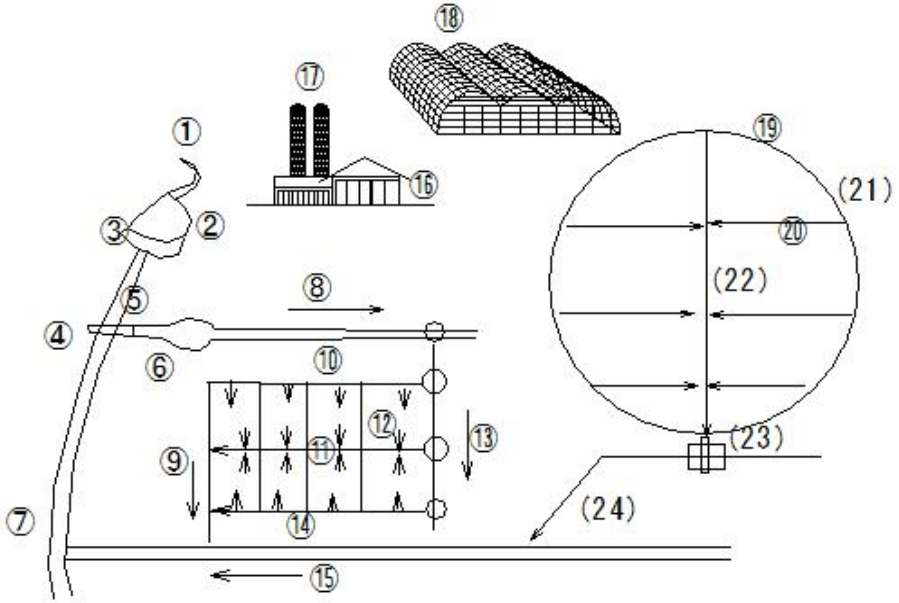
Agricultural water

Livestock water

①Water needed to raise livestock such as cows, pigs, and chickens

②Used for drinking water, maintaining the breeding environment, cleaning, etc.

⑯Animal barn
⑰Silo



Layout of farmland and various facilities

I334
1413

(I826) Water requirement for field irrigation

(I826) Water requirement for field irrigation

Water requirement for field irrigation

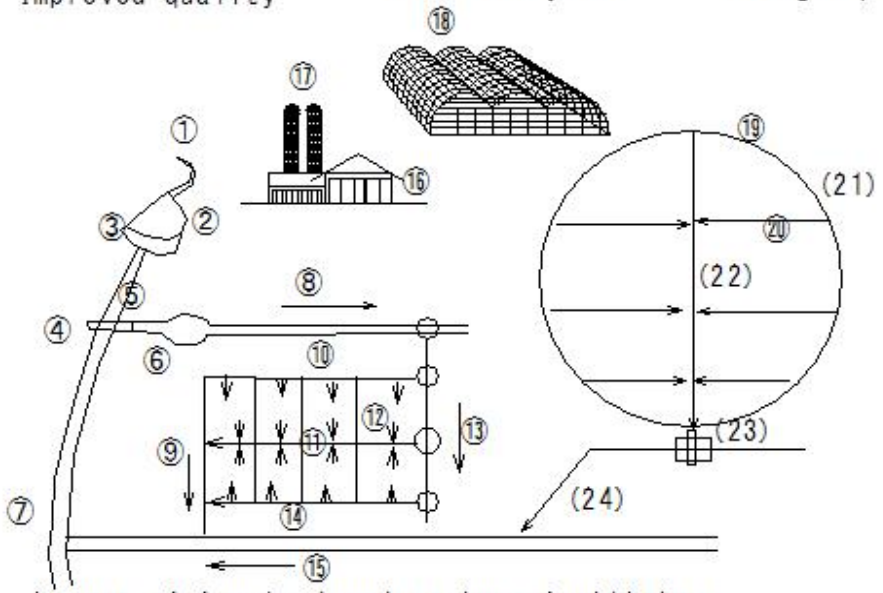
Field irrigation

① Water is pumped up from a reservoir or irrigation channel and spread over the entire field using furrow irrigation, sprinklers, perforated pipes, etc.

② It is designed to supply the amount of water necessary for crop growth.

Benefits

・Easy cultivation management ・Improved quality ・Increased yield ・Drought prevention



⑲Surface drainage of fields
⑳Conveyor channel
(21)Field
(22)Collecting channel
(23)Sand dam
(24)Branch drainage channel

Layout of farmland and various facilities

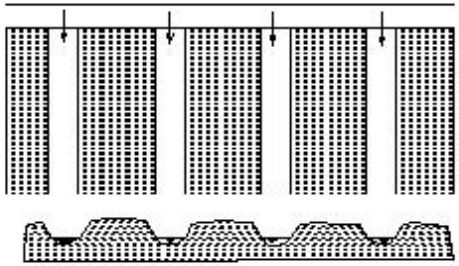
I334
1413

(I827) Water requirements for field irrigation

(I827) Water requirements for field irrigation

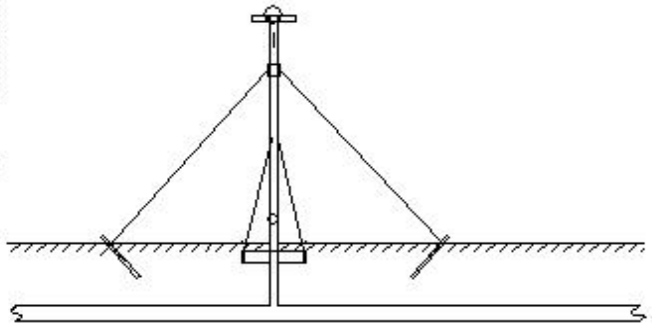
Water requirements for field irrigation

①Furrow irrigation:　②Sprinkler:　③Perforated pipe:



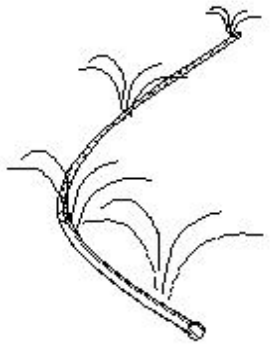
Furrow irrigation

I175



Sprinkler

I160



Perforated pipe:

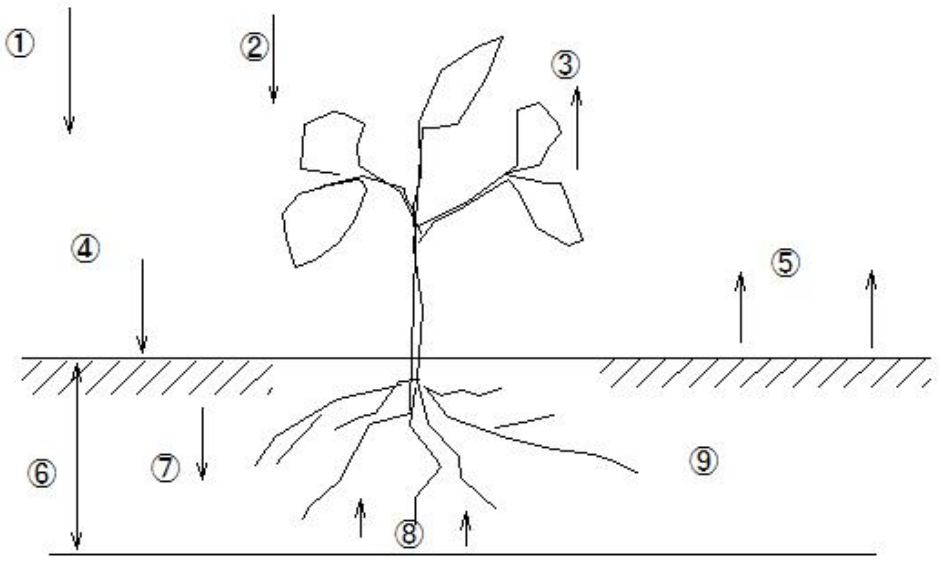
I479

(I828) Water requirement for field irrigation

(I828) Water requirement for field irrigation

Water consumption in fields

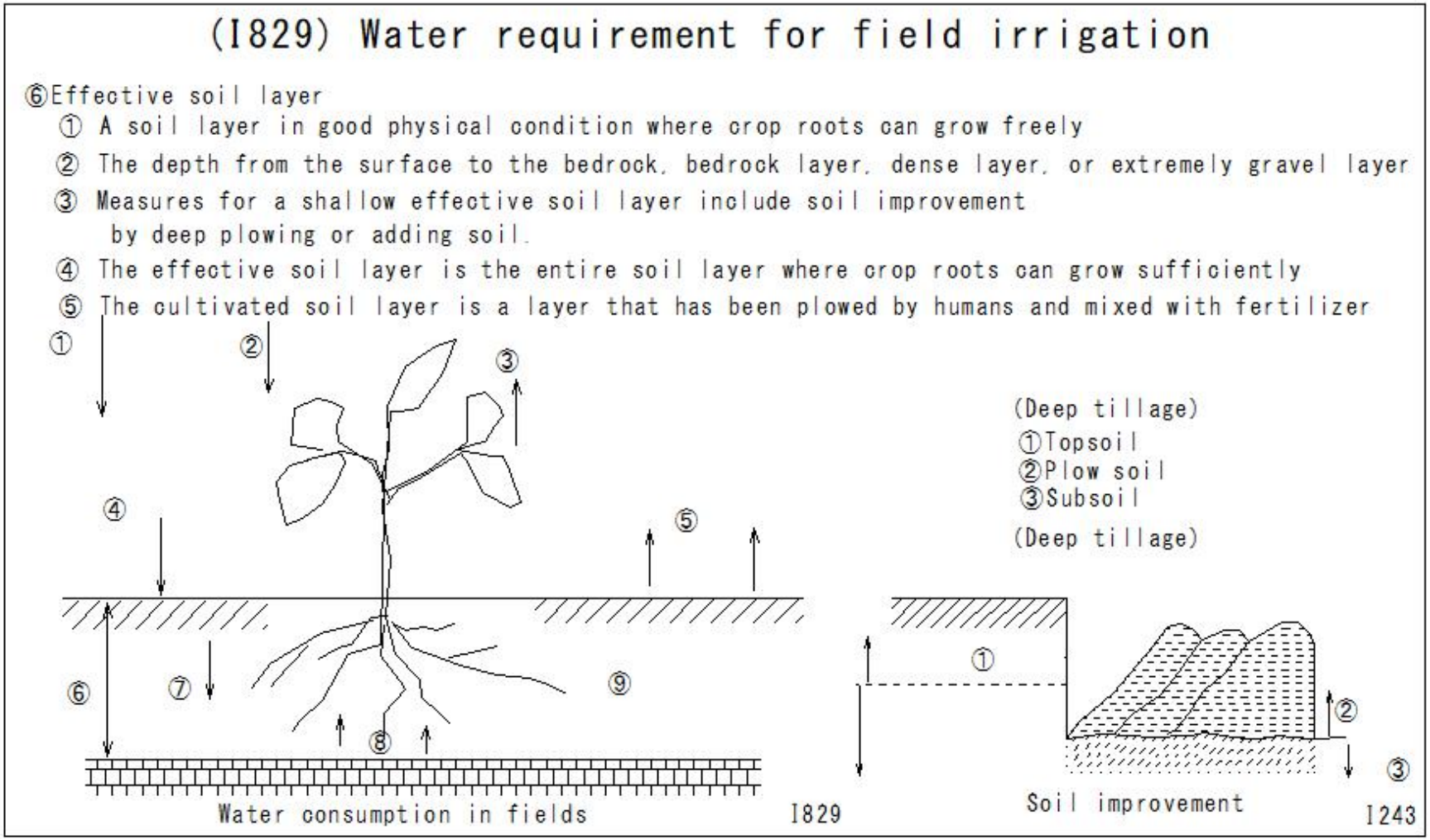
①Irrigation
②Rainfall
③Transpiration
④Soil surface
⑤Evaporation
⑥Effective soil layer
⑦Infiltration
⑧Capillary water
⑨Root zone



Water consumption in fields

①Water consumption in fields refers to the amount of water required to grow plants in the field
②It varies depending on soil moisture, climate, type of crop, growth conditions, etc.
③Water is supplied by irrigation and water is supplied by rain, etc.
④By understanding soil moisture consumption (SMEP), the appropriate amount of irrigation can be determined.

(I829) Water requirement for field irrigation



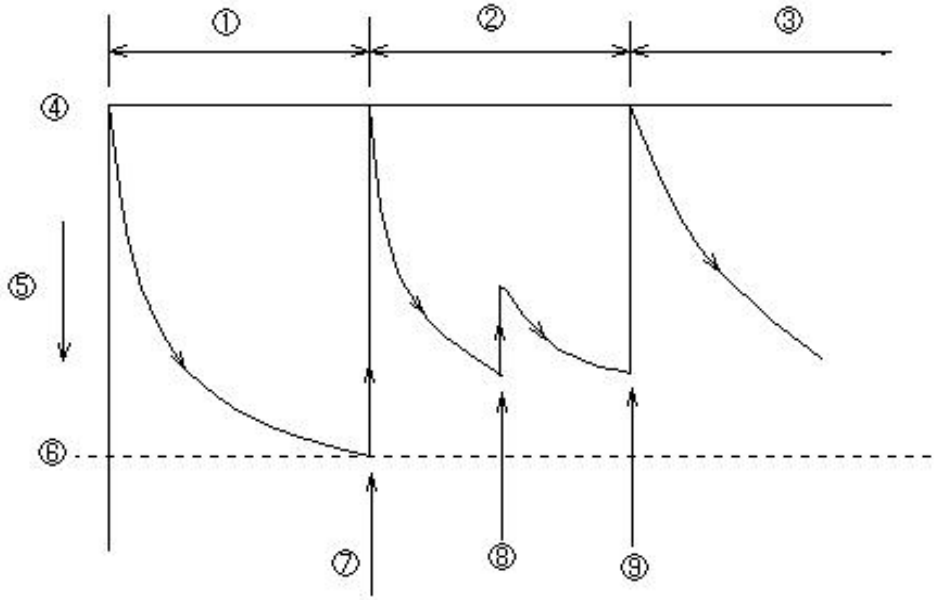
(I830)Intermittent irrigation

(I830)Intermittent irrigation

Intermittent irrigation

Changes in soil moisture and number of intermittent days

①Number of intermittent days
②Number of intermittent days
③Number of intermittent days
④Field water capacity
⑤Changes in soil moisture
⑥Growth inhibition moisture point
⑦Irrigation
⑧Effective rainfall
⑨Irrigation



Intermittent irrigation　　Changes in soil moisture and number of intermittent days

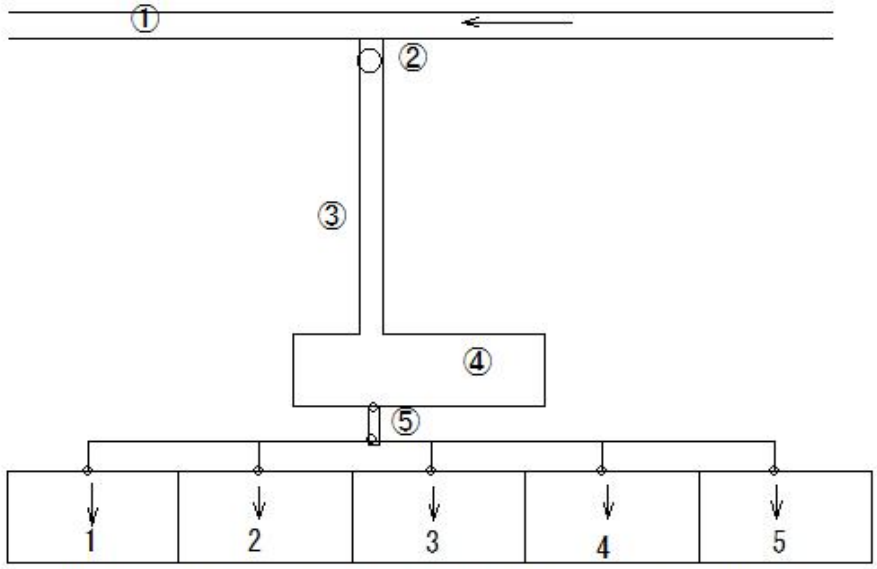
①Water is stored in the paddy field soil for a certain period of time
②It is a water management technique that repeatedly drains water for a certain period of time
③It helps roots breathe and promotes fertilizer absorption in the growth of rice
④It also helps improve the paddy field environment

(I831) Rotation block

(I831) Rotation block

Rotation block and water distribution system

① Main irrigation canal
② Diversion works
③ Branch irrigation canal
④ Farm pond
⑤ Diversion valve



Rotation block and water distribution system

① A method of crop rotation mainly used in agriculture, in which a field is divided into several plots and a different crop is cultivated in each plot

② An irrigation planning area is divided into several zones, and the order of irrigation within each zone is decided, and when irrigating, irrigation is performed in rotation for each zone.

(I832) Field irrigation efficiency

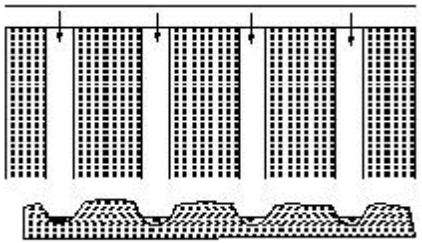
(I832) Field irrigation efficiency

Field irrigation efficiency

Irrigation efficiency is an index that shows the ratio between the amount of water supplied to crops by irrigation and the amount of water actually used for irrigation.

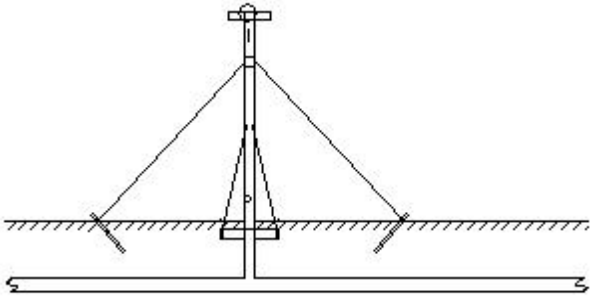
Field irrigation efficiency

①Irrigation method	④Application efficiency	⑤Conveyance efficiency	⑥Irrigation efficiency
	Ea(%)	Ec(%)	Ei(%)
②Sprinkle irrigation	80～90	85～95	70～85
③Furrow irrigation	70	85～95	60～65



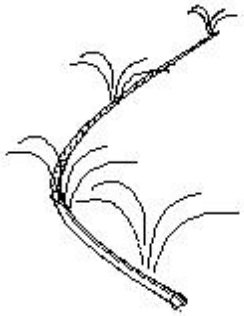
Furrow irrigation

I175



Sprinkler

I160



Perforated pipe:

I479

(I833) Surface irrigation

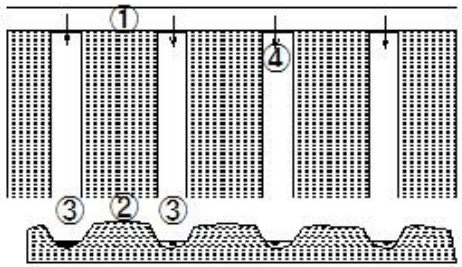
(I833) Surface irrigation

Field irrigation

Surface irrigation

Surface irrigation is a method of irrigating by storing water on the surface of the ground.

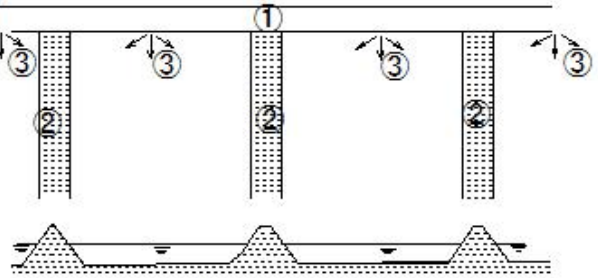
① Water supply channel
② Furrow
③ Furrow
④ Water



(Furrow irrigation)

I175

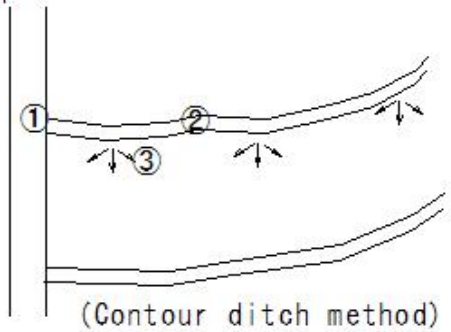
① Water supply channel
② Bank
③ Water



(Border method)

I176

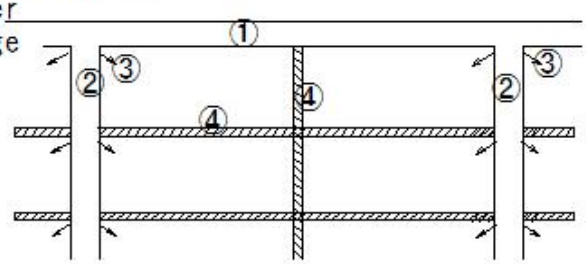
① Water supply channel
② Contour ditch
③ Water



(Contour ditch method)

I177

① Main channel
② Branch channel
③ Water
④ Ridge



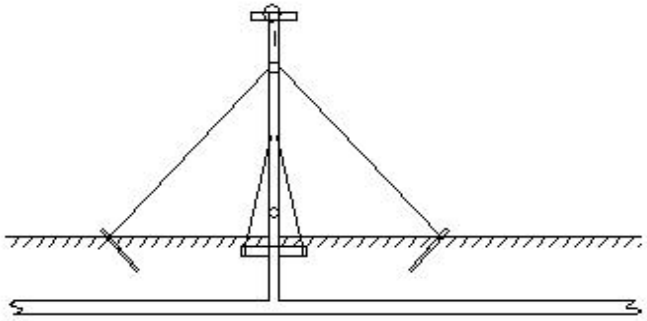
(Division method/Basin method)

I178

(I834) Sprinkler Irrigation

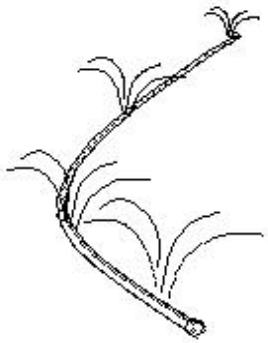
(I834) Sprinkler Irrigation

Field irrigation



Sprinkler

I160



Perforated pipe

I479

(I835)Intake rate

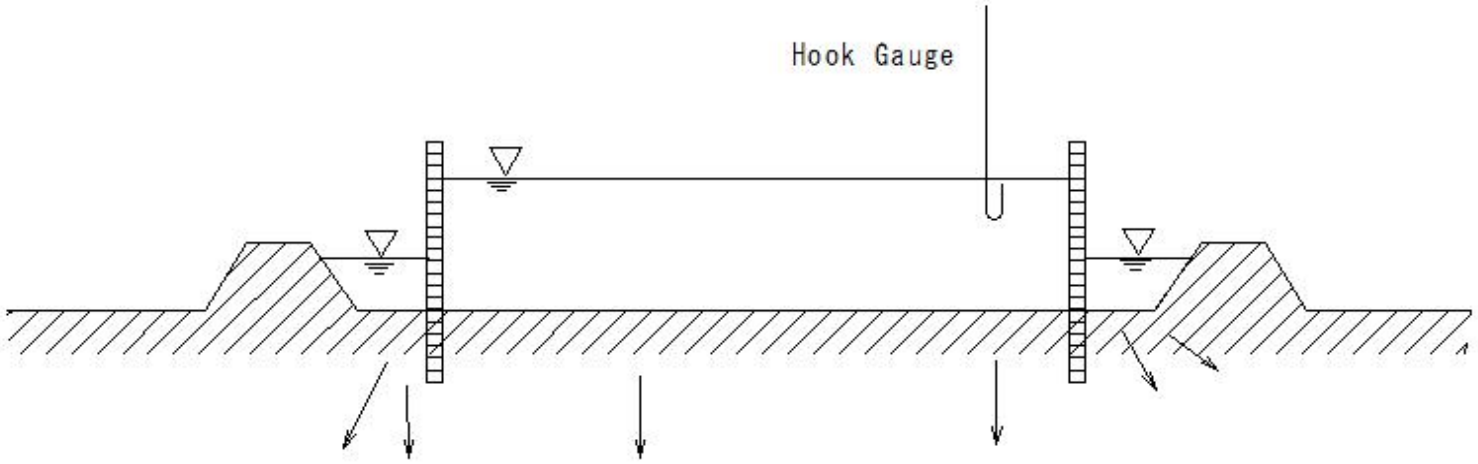
(I835) Intake rate

Field irrigation

Intake rate

① Intake rate is the amount of water absorbed by soil per unit time

② The rate at which irrigation water, rainwater, etc. seeps into the soil from the surface

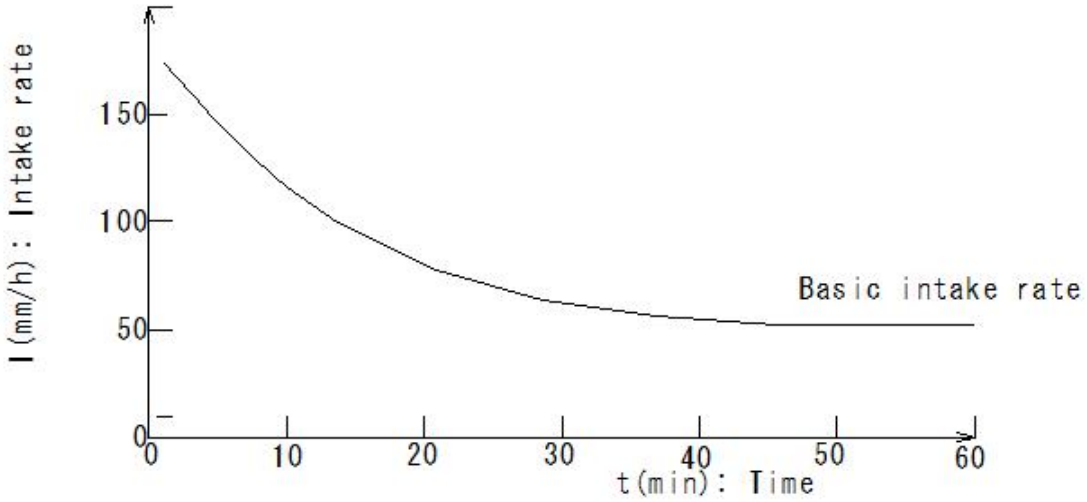


(I836) Basic intake rate

(I836) Basic intake rate

Field irrigation

The basic intake rate is the intake rate when the rate has almost stopped decreasing over time and has become almost constant.



(I837) Water requirement for paddy field irrigation

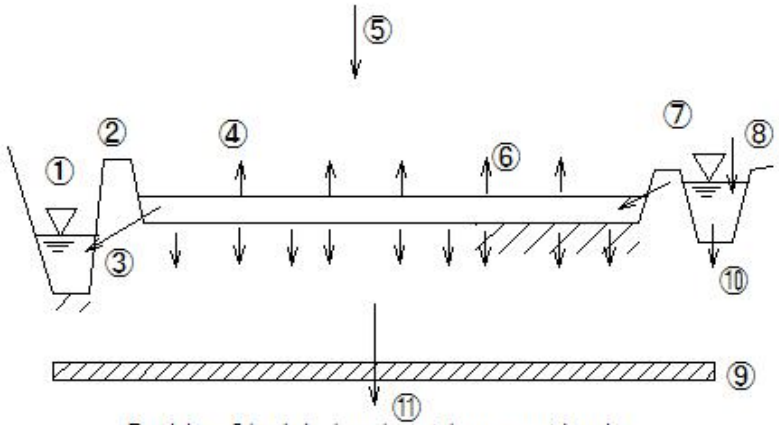
(I837) Water requirement for paddy field irrigation

Water requirement for paddy field irrigation

Water requirement per field

Figure: Schematic diagram of water consumption in paddy fields

①Drainage channel
②Drainage channel
③Ridge infiltration
④Evaporation
⑤Rainfall
⑥Transpiration
⑦Irrigation
⑧Irrigation channel
⑨Plow pan
⑩Channel infiltration
⑪Descent infiltration



Paddy field irrigation methods

Figure: Schematic diagram of water consumption in paddy fields

(I838) Water requirement for paddy field irrigation

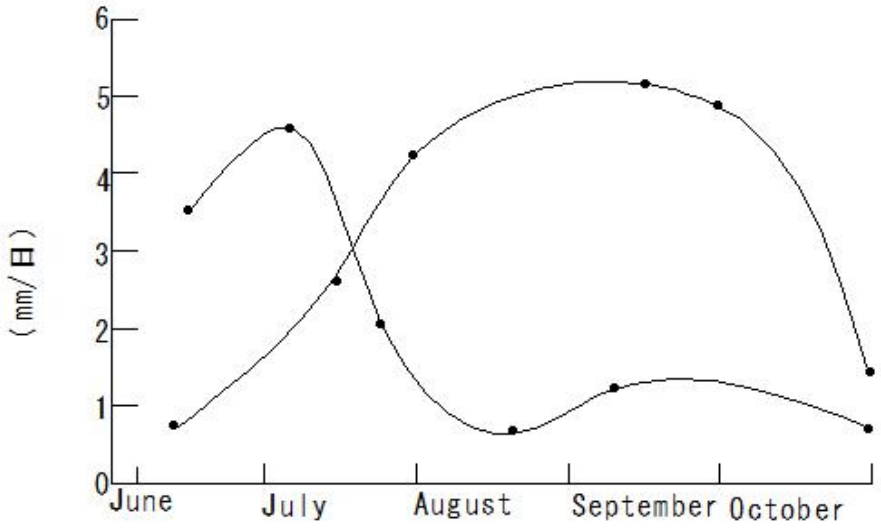
(I838) Water requirement for paddy field irrigation

Evapotranspiration

①The amount of water vapor returned to the atmosphere in a certain area through evaporation from the ground surface and transpiration from plants

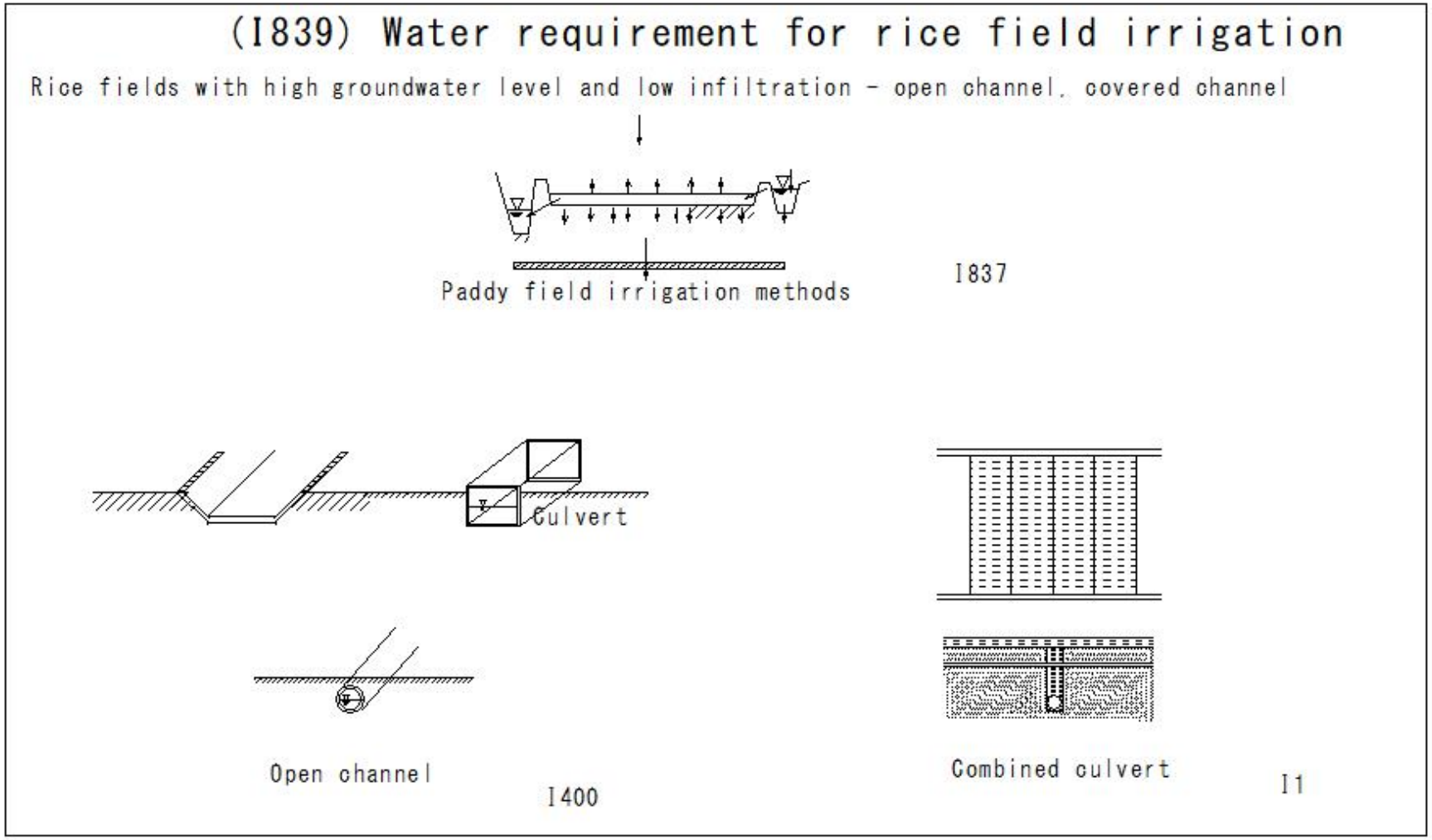
②The units are expressed as mm/day or mm/year, and vary depending on the weather and type of plant.

Evapotranspiration = (precipitation + infiltration - runoff - water level change)

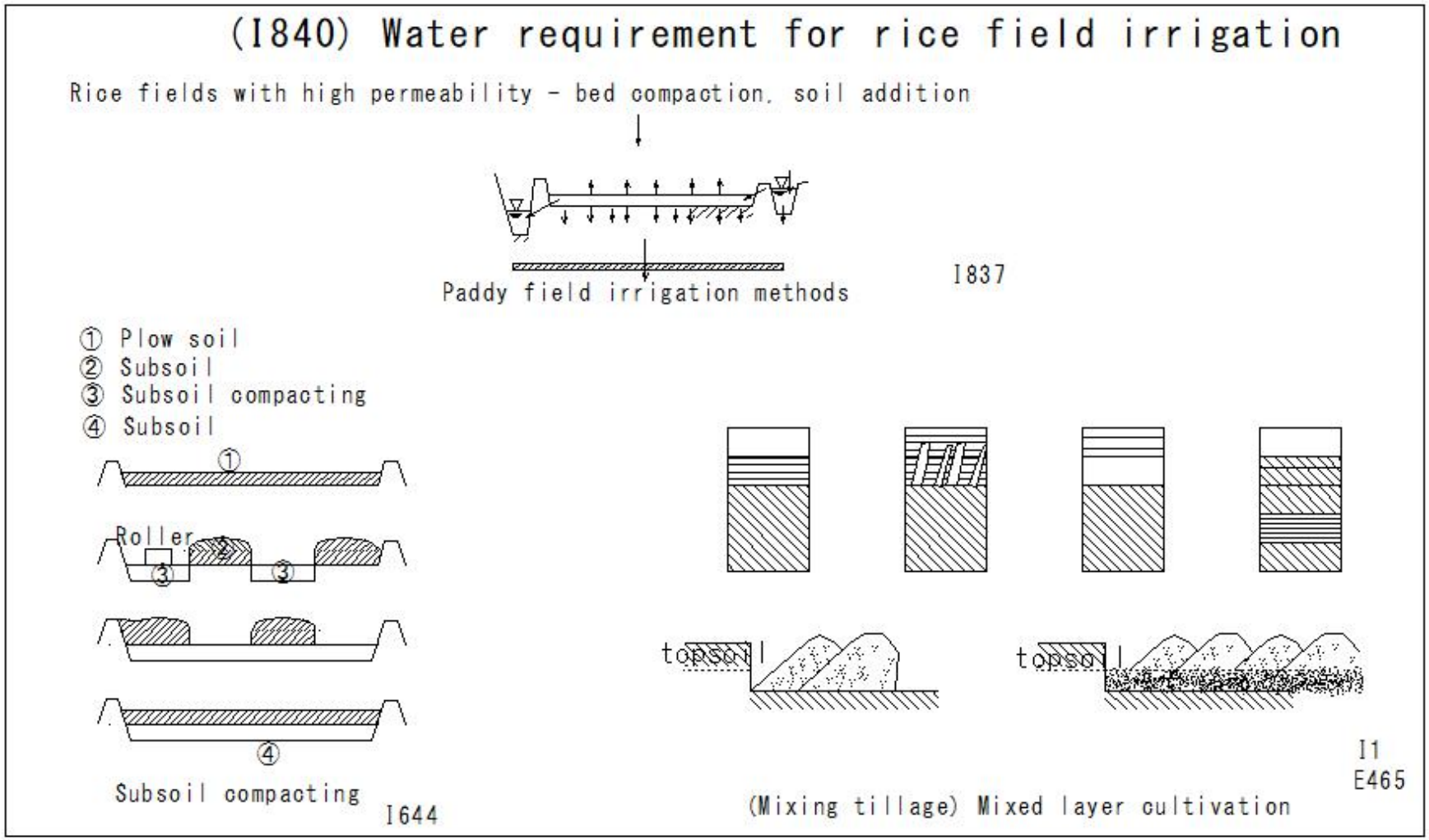


Changes in evaporation and transpiration rates under normal cultivation

(I839) Water requirement for rice field irrigation



(I840) Water requirement for rice field irrigation



(I841) Water requirement for rice field irrigation

(I841) Water requirement for rice field irrigation

Water volume required for cultivation management

① Refers to the amount of water required for water management (irrigation, drainage, etc.) during the crop cultivation period to affect the growth and quality of the crop.

② Not only for hydrating the crops, but also for soil management (mid-season drainage, flooding before rice planting, etc.)

Water management

① Watering, plowing

② Rice planting (young seedlings planted/sowed seedlings → drainage)

③ Rooting period (deep water: protect young seedlings, suppress evaporation, absorb water)

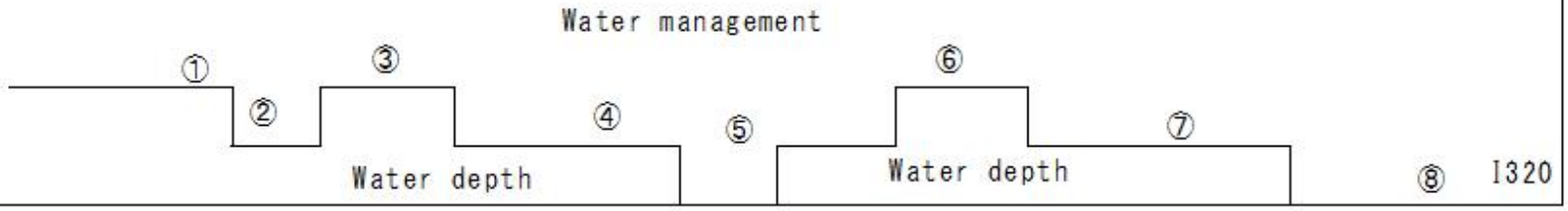
④ Tillering period (shallow water: promote tilling, when using herbicide/top dressing → drainage)

⑤ Maximum tillering period (drainage/mid-drying for 1 week: suppress ineffective tillers, supply oxygen to the ground)

⑥ Heading period (deep water: requires a lot of water, promotes infiltration)

⑦ Ripening period (shallow water: reduces evapotranspiration, intermittent irrigation: supplies oxygen)

⑧ Harvest period (drainage about 30 days after ears are uniform)

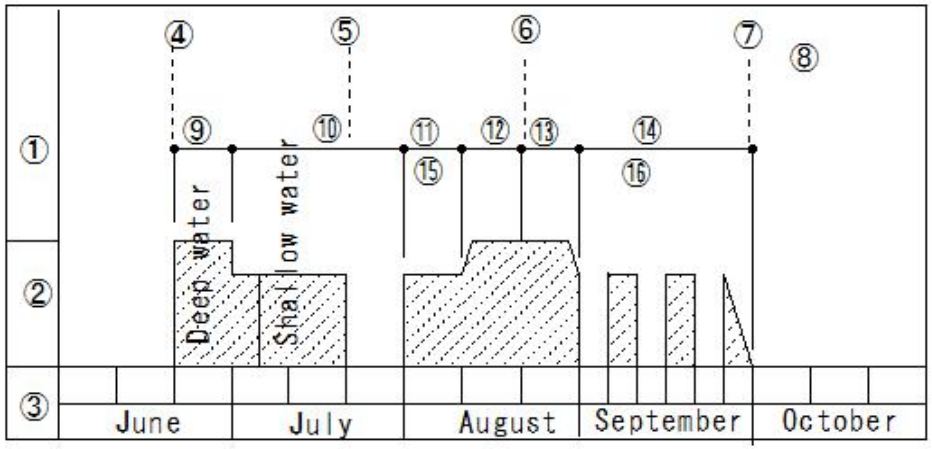


(I842) Water requirement for rice field irrigation

(I842) Water requirement for rice field irrigation

Changes in water requirement per field in rice paddies by season

①Growth period and progress
②Water management
③Month
④Rice planting
⑤Drying
⑥Heading
⑦Water removal
⑧Harvesting period (water removal about 30 days after ears are uniform)
⑨Establishment period
⑩Tillering period
⑪Young panicle formation period
⑫Head disintegration period
⑬Heading and flowering period
⑭Ripeness period
⑮Occasional drying
⑯Intermittent irrigation



Water management for rice cultivation in the normal season

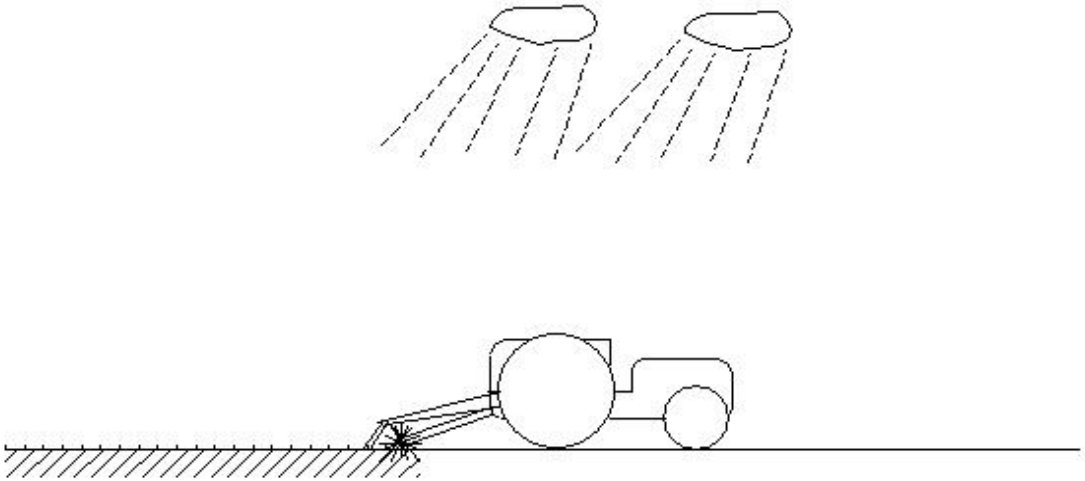
(I843) Water requirement for rice field irrigation

(I843) Water requirement for rice field irrigation

Plowing (Puddling)

Puddling: In rice paddies, the soil is first plowed, then water is added and the soil is stirred up with a machine to turn it into a muddy state.

By softening the rice field soil, seedlings can take root more easily, water leakage is prevented, and fertilizer and pesticides are more effective.



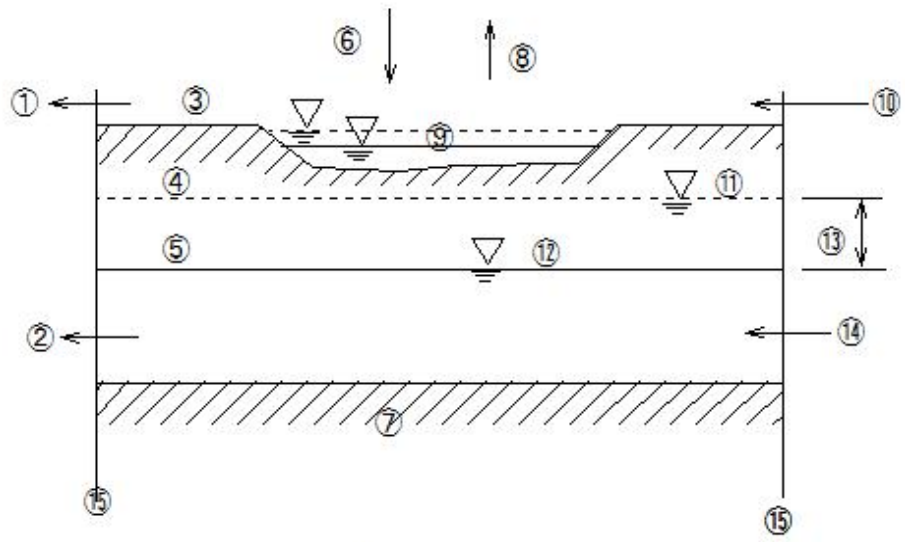
I126

(I844) Water requirement for rice field irrigation

(I844) Water requirement for rice field irrigation

Water balance

① Surface water runoff D2
② Groundwater runoff G3
③ Land surface
④ ⊿M Soil moisture change
⑤ Pe Effective porosity
⑥ Precipitation P
⑦ Impermeable layer
⑧ Evapotranspiration
⑨ ⊿WS Change in surface water storage
⑩ D1 Surface water inflow
⑪ Groundwater level before change
⑫ Groundwater level after change
⑬ ⊿H Groundwater level change
⑭ G1: Groundwater inflow
⑮ Area boundary



Water balance

$P = (D2-D1) + E + (G2 - G1) + \Delta S$

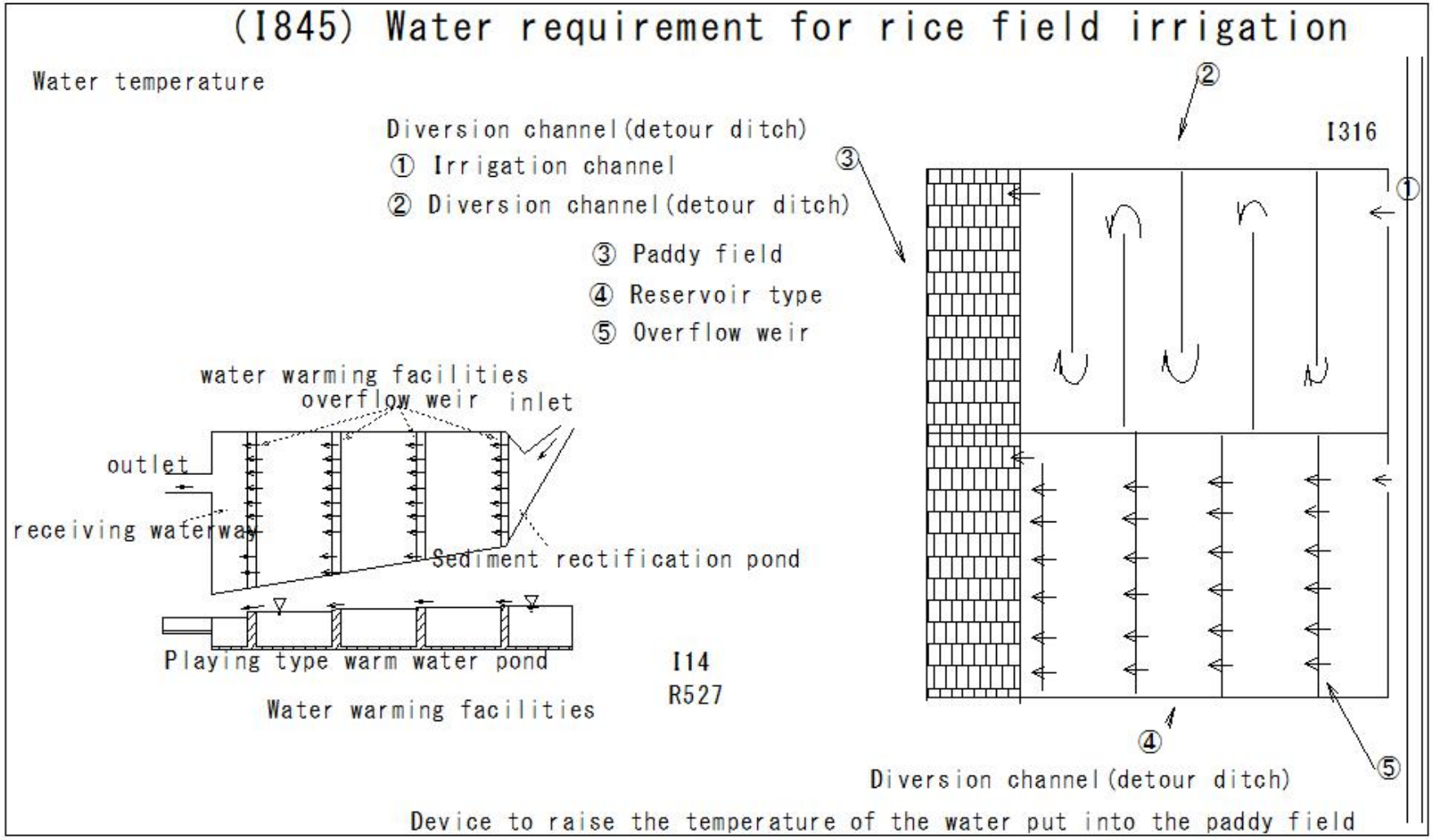
$\Delta S = Pe\Delta H + \Delta M + \Delta Ws$

① Water balance is the balance between the amount of water inflow and outflow per unit time in a certain area or system.

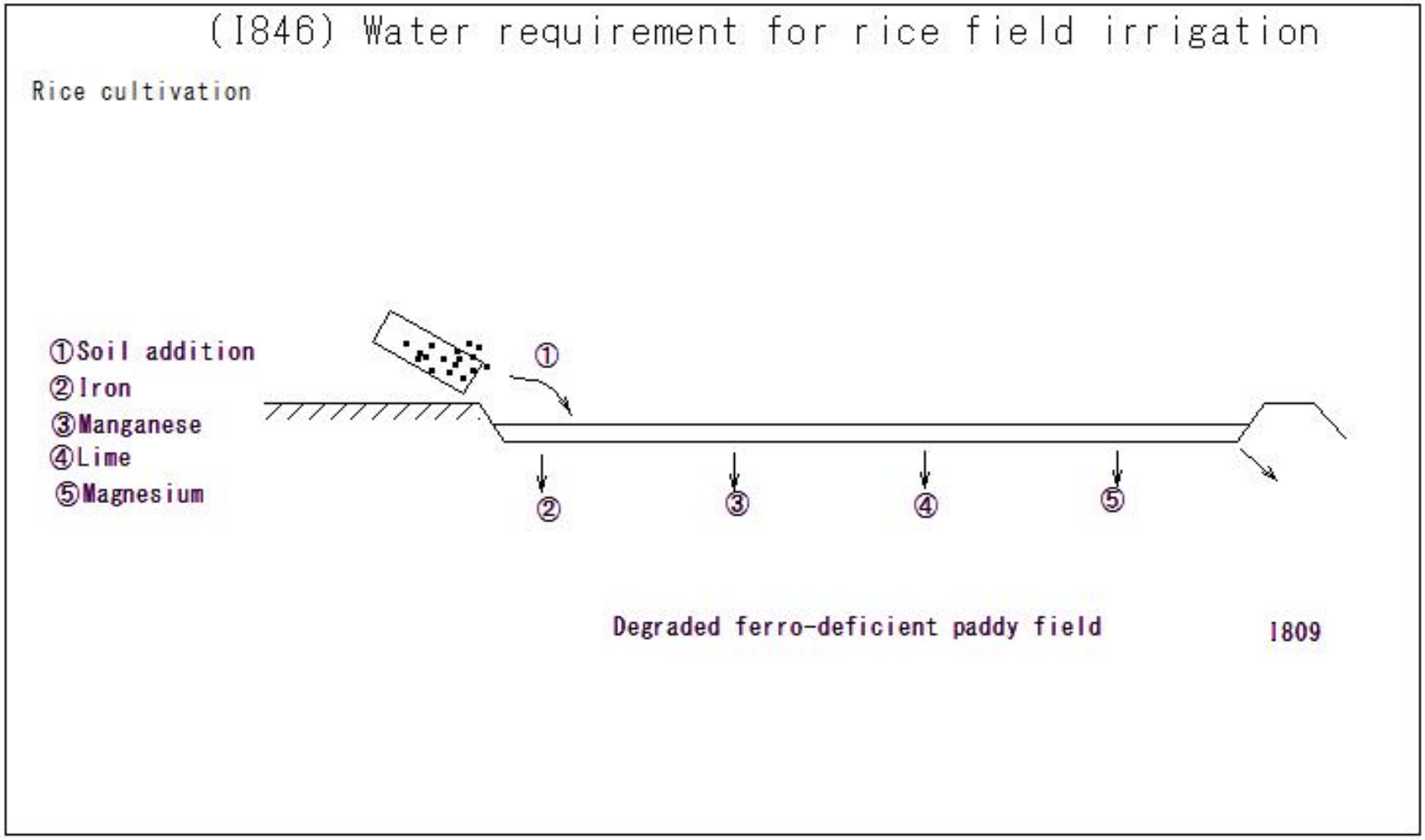
② Specifically, we calculate the change in water storage by taking into account precipitation, evaporation, transpiration, ground infiltration, river flow, etc.

I263

(I845) Water requirement for rice field irrigation



(I846) Water requirement for rice field irrigation

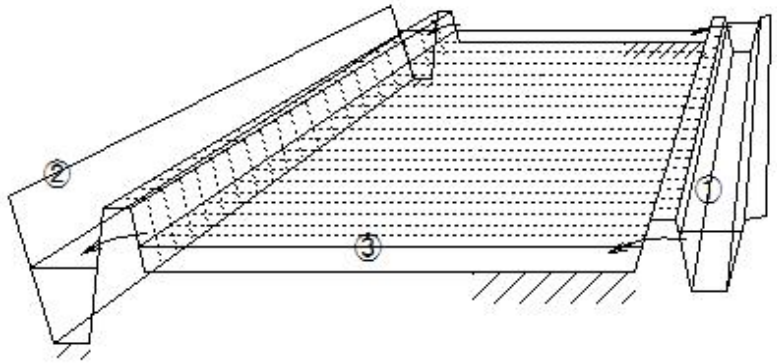


(I847) Paddy field irrigation

(I847) Paddy field irrigation

Continuous irrigation

① Irrigation channel
② Drainage channel
③ Water is passed through an inlet cut into the bank and flows from paddy field to paddy field



Continuous irrigation

① A method of constantly supplying water for a certain period of time
② In case of water is abundant or in places, it is run-off
③ Uneconomical in terms of water volume
④ Prevention of high temperature damage

(I848) Paddy field irrigation

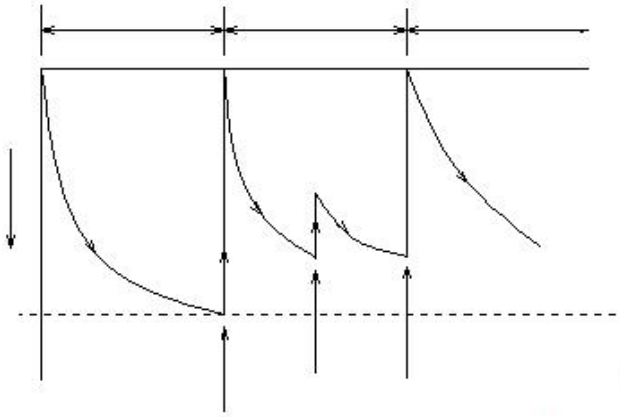
(I848) Paddy field irrigation

Intermittent irrigation (AWD (Alternating Wetting and Drying))

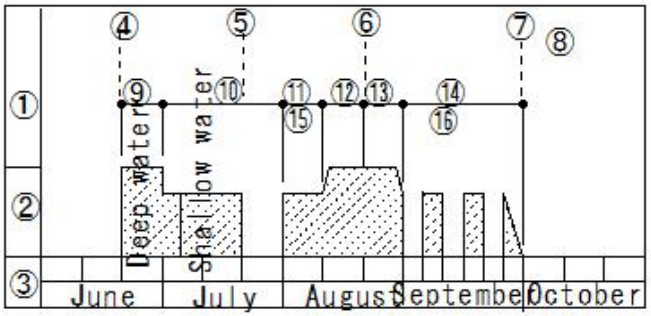
①This is a water management technique in which the soil of a paddy field is flooded (stored with water) for a certain period of time, and then drained (drained) for a certain period of time.

②It is said to help the roots breathe and promote fertilizer absorption in the growth of rice, and also helps improve the paddy field environment.

③The paddy field is alternately flooded with water (flooded) and drained to dry the soil (drained).



I830



Water management for rice cultivation in the normal season

I842

Intermittent irrigation (AWD (Alternating Wetting and Drying))

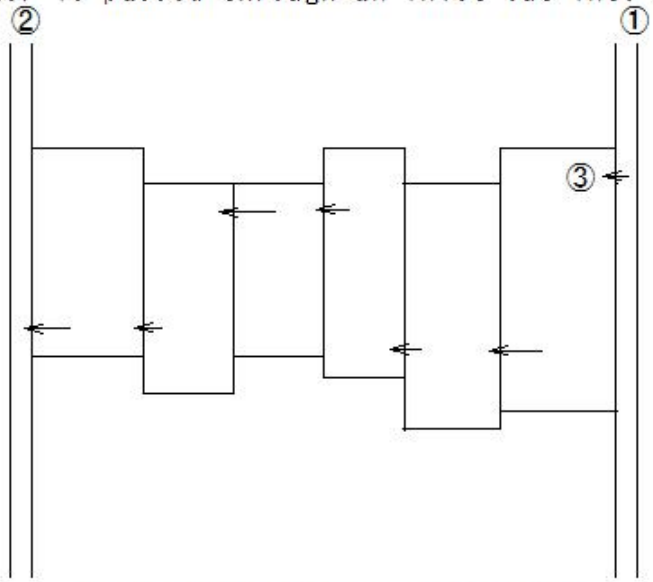
(I849) Paddy field irrigation

(I849) Paddy field irrigation

Rice field crossing irrigation

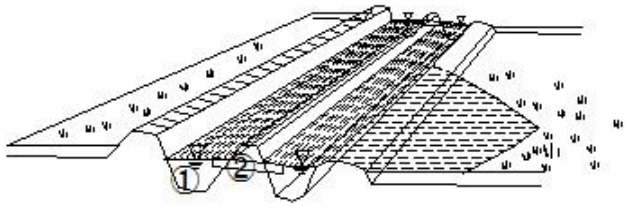
- In rice field crossing irrigation, the water used in the field is not dumped into the drainage channel, but is dumped into the adjacent field below, and the water is used
- Water can be saved and muddy water can be prevented from running off.

① Irrigation channel
② Drainage channel
③ Water is passed through an inlet cut into the bank and flows from paddy field to paddy field



Rice field crossing irrigation I34

Flood Irrigation(Overflow irrigation)
① Branch canal
② Irrigation canal



I386

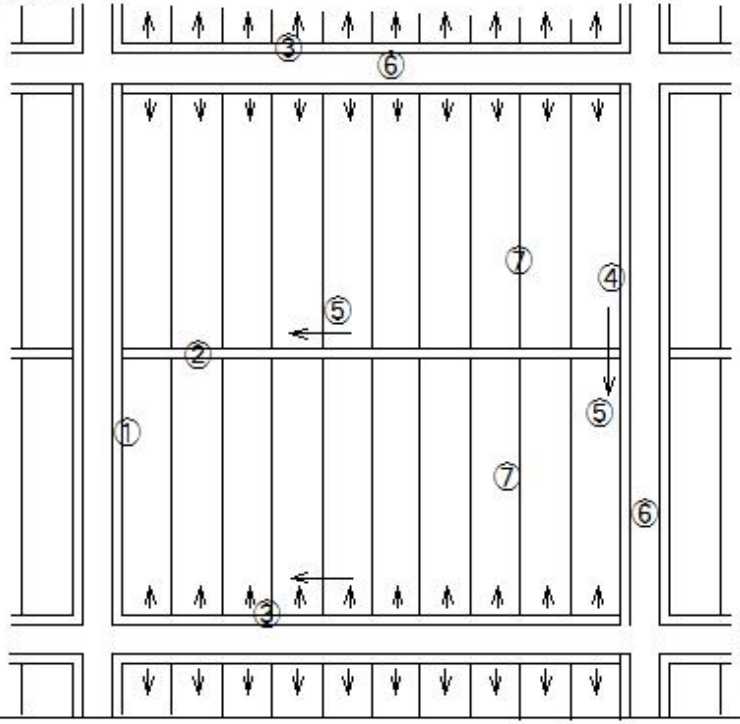
(I850) Paddy field irrigation

(I850) Paddy field irrigation

Separate water supply and drainage irrigation

- An irrigation system in which the routes for agricultural water (use) and drainage (drainage) are completely separated.
- Water management can be efficiently performed for each field, which helps prevent turbidity and pollution of drainage water.

① Branch drainage channel
② Small drainage channel
③ Small irrigation channel
④ Branch irrigation channel
⑤ Water movement
⑥ Farm road
⑦ Rice ridge



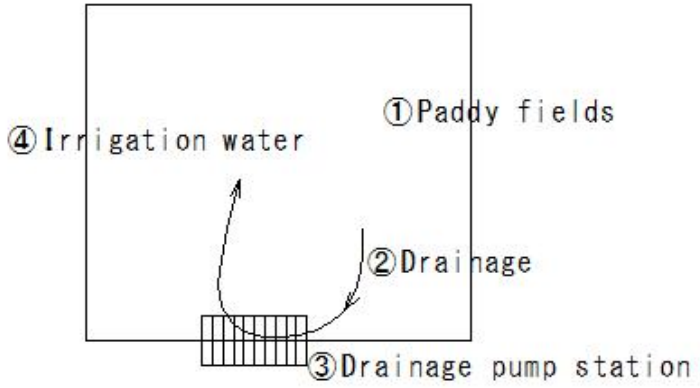
Paddy field plot

(I851) Paddy field irrigation

(I851) Paddy field irrigation

Circulating irrigation

1. This method recycles and reuses water taken in for agricultural use without discharging it.
2. This method uses a pump to pump water discharged from rice paddies and return it to the same paddy field or to another paddy field in the area.
3. This method is expected to reduce the amount of wastewater and suppress runoff loads of nitrogen, phosphorus, etc.



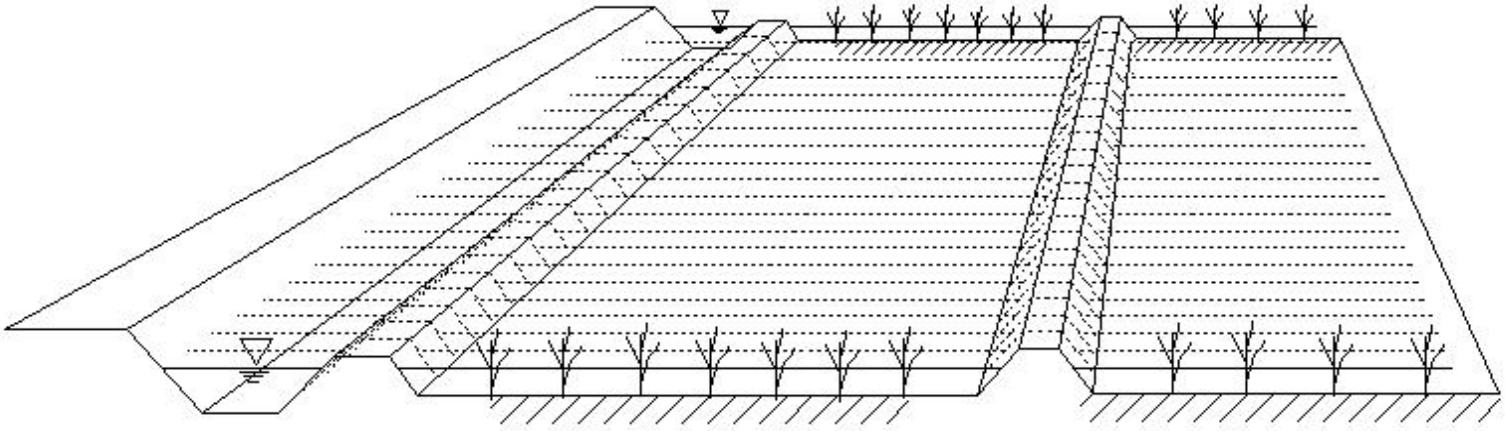
Circulating irrigation

(I852) Paddy field irrigation

(I852) Paddy field irrigation

Effects

①Rice growth
②Weed suppression
③Pest prevention
④Stabilization of soil temperature
⑤Diffusion of fertilizer components
⑥Prevention of continuous crop damage
⑦Effective use of water resources



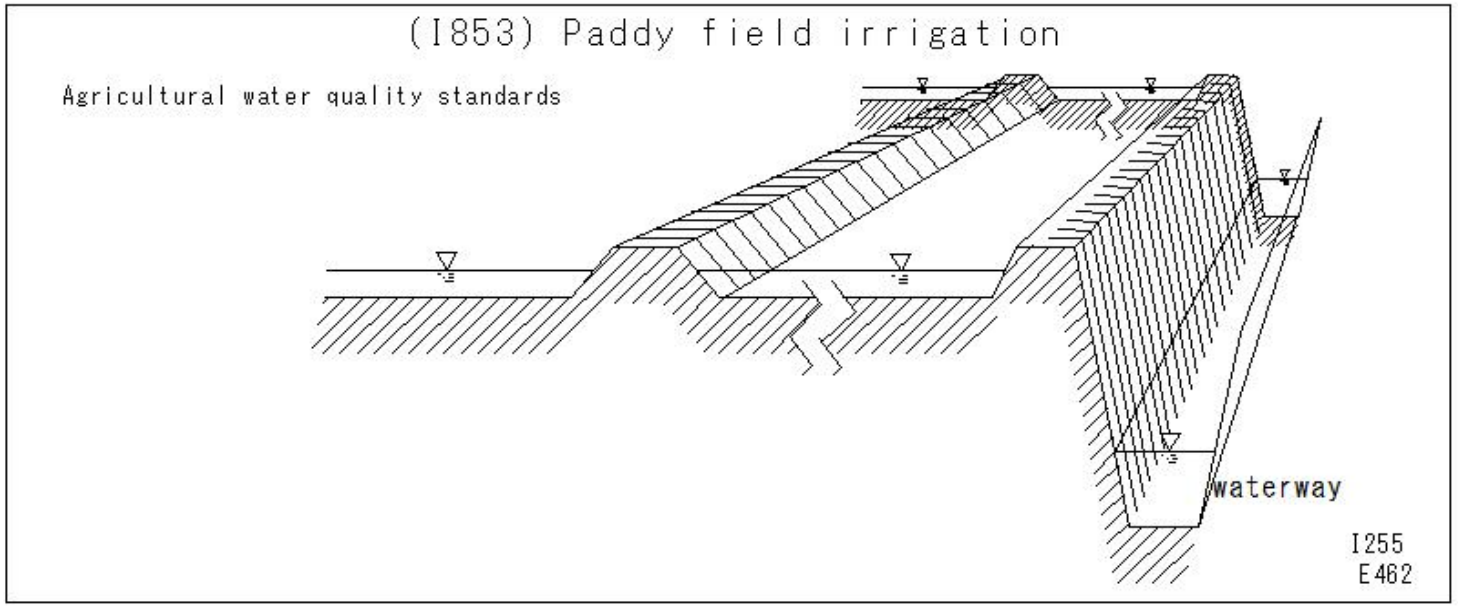
I465

(I853) Paddy field irrigation

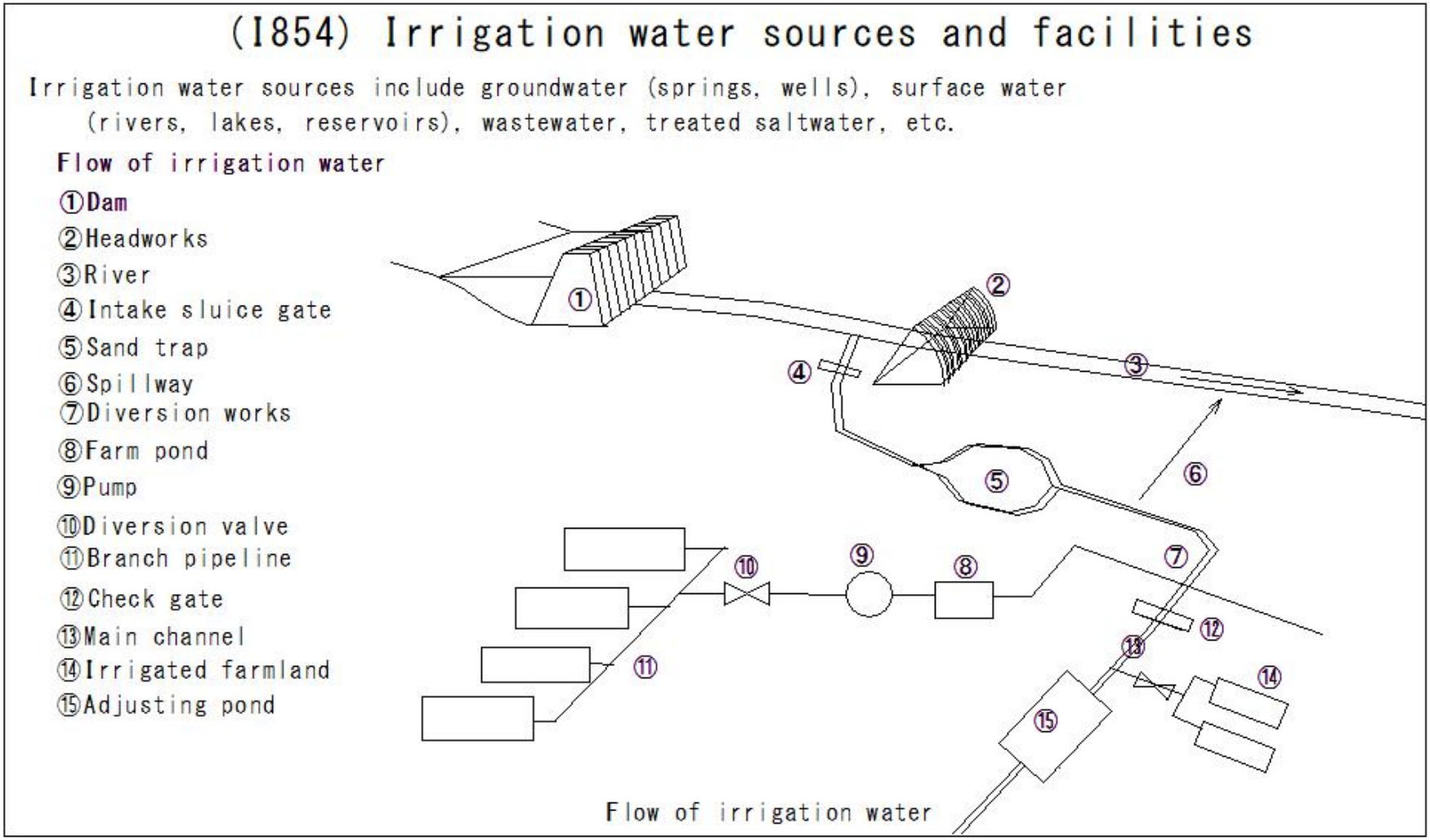
Agricultural water quality standards
pH: 6.0-7.5
COD (chemical oxygen demand): 6mg/L or less
SS (suspended solids): 100mg/L or less
DO (dissolved oxygen): 5mg/L or more
Standards are also set for the following substances:
T-N (total nitrogen): 1mg/L or less
T-P (total phosphorus): 0.1mg/L or less
Electrical conductivity (EC): 0.3mS/cm or less
Heavy metals: Permissible concentrations are set

Field irrigation water:

For field irrigation water, the permissible limit for chlorine is 200-250mg/L
Based on field experience, a salinity of 0.25% is considered the guideline for stopping water intake.



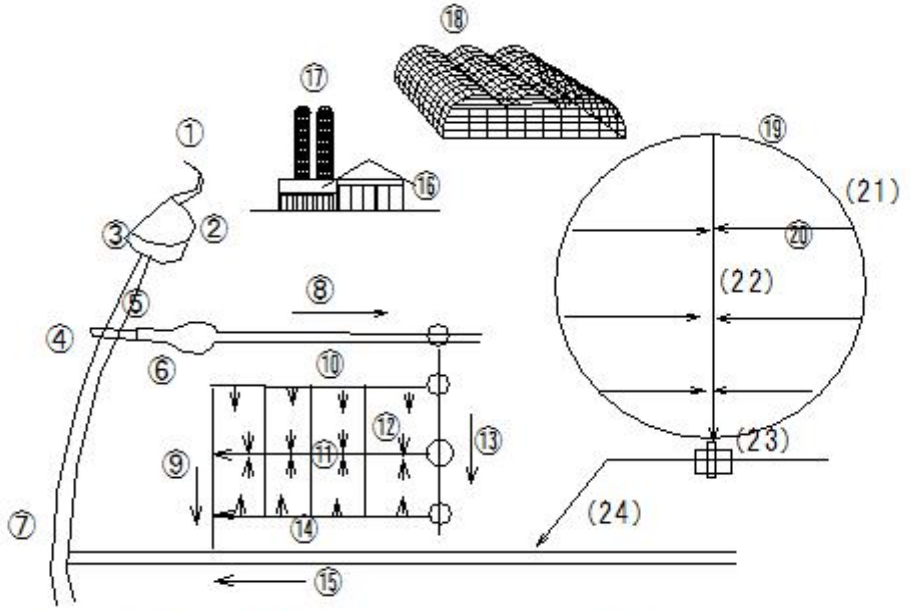
(I854) Irrigation water sources and facilities



(I855) Irrigation water sources and facilities

(I855) Irrigation water sources and facilities

①Upstream of river
②Reservoir
③Dam
④Weir
⑤Intake
⑥Sand trap
⑦River
⑧Main irrigation channel
⑨Branch drainage channel
⑩Small irrigation channel
⑪Small drainage channel
⑫Rice field
⑬Branch irrigation channel
⑭Small irrigation channel
⑮Main drainage channel
⑯Animal barn
⑰Silo
⑱House
⑲Surface drainage of fields
⑳Conveyor channel
(21)Field
(22)Collecting channel
(23)Sand dam
(24)Branch drainage channel



Layout of farmland and various facilities 1413

I334

(I856) Irrigation water sources and facilities

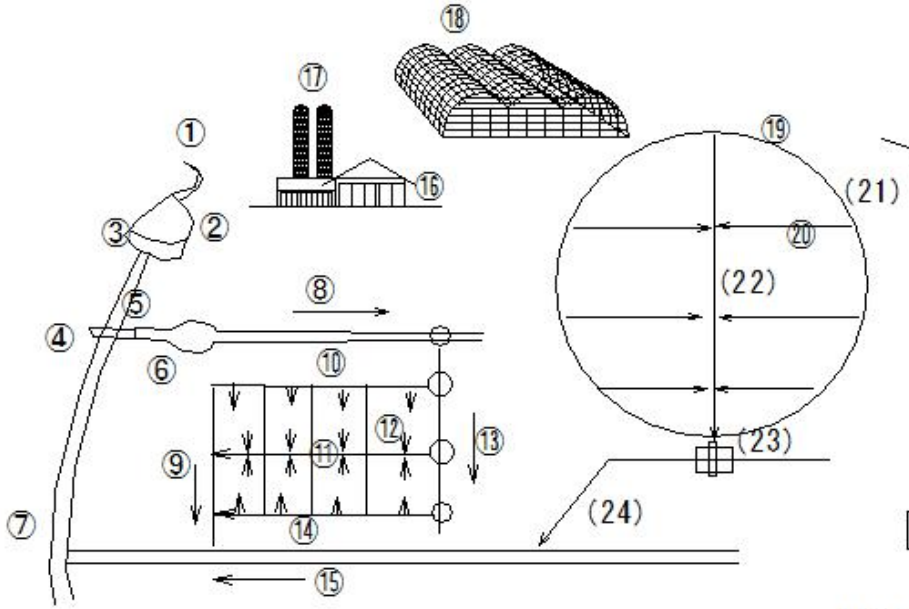
(I856) Irrigation water sources and facilities

Irrigation water sources

① The source of water used to supply water for growing crops.

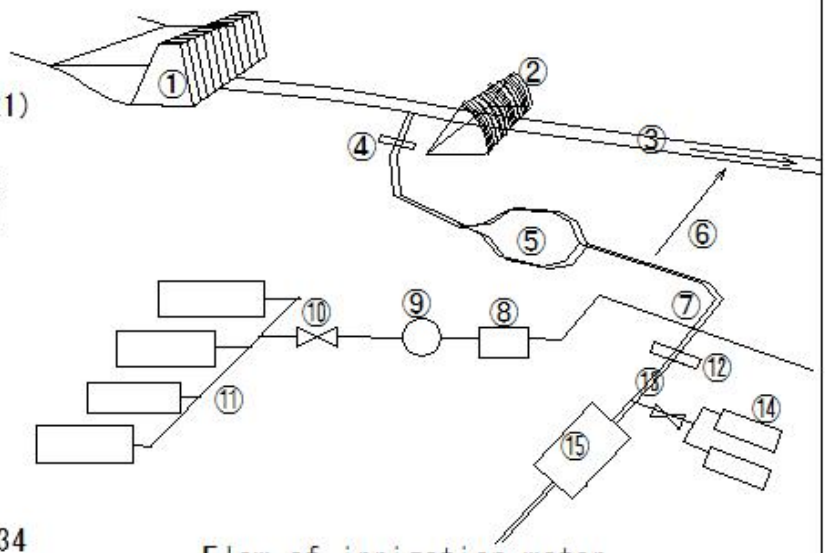
② Rivers, lakes, dams, reservoirs, groundwater

③ For paddy field irrigation, water is mainly taken from rivers and drawn to the paddy fields through irrigation canals.



Layout of farmland and various facilities

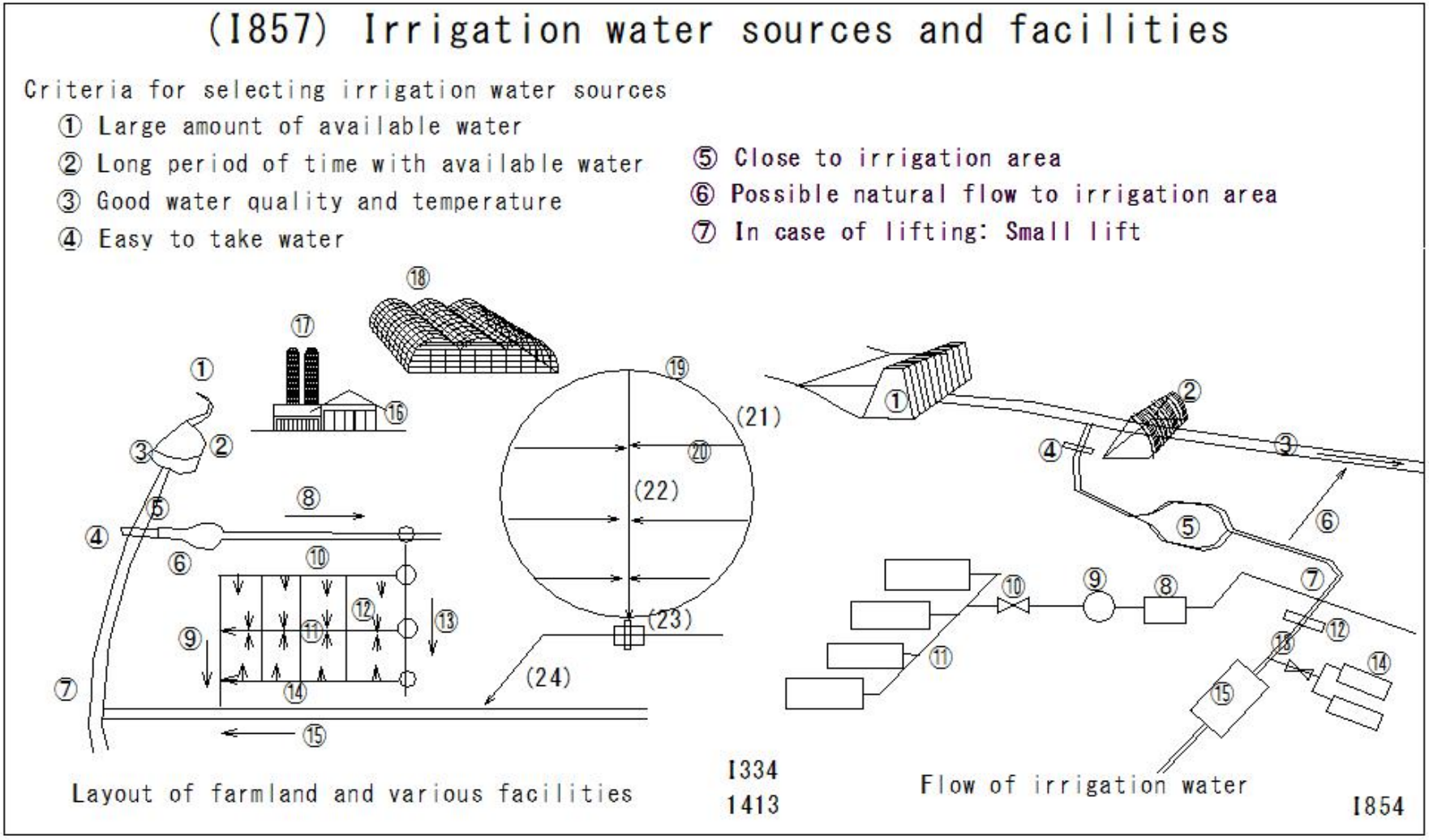
I334
1413



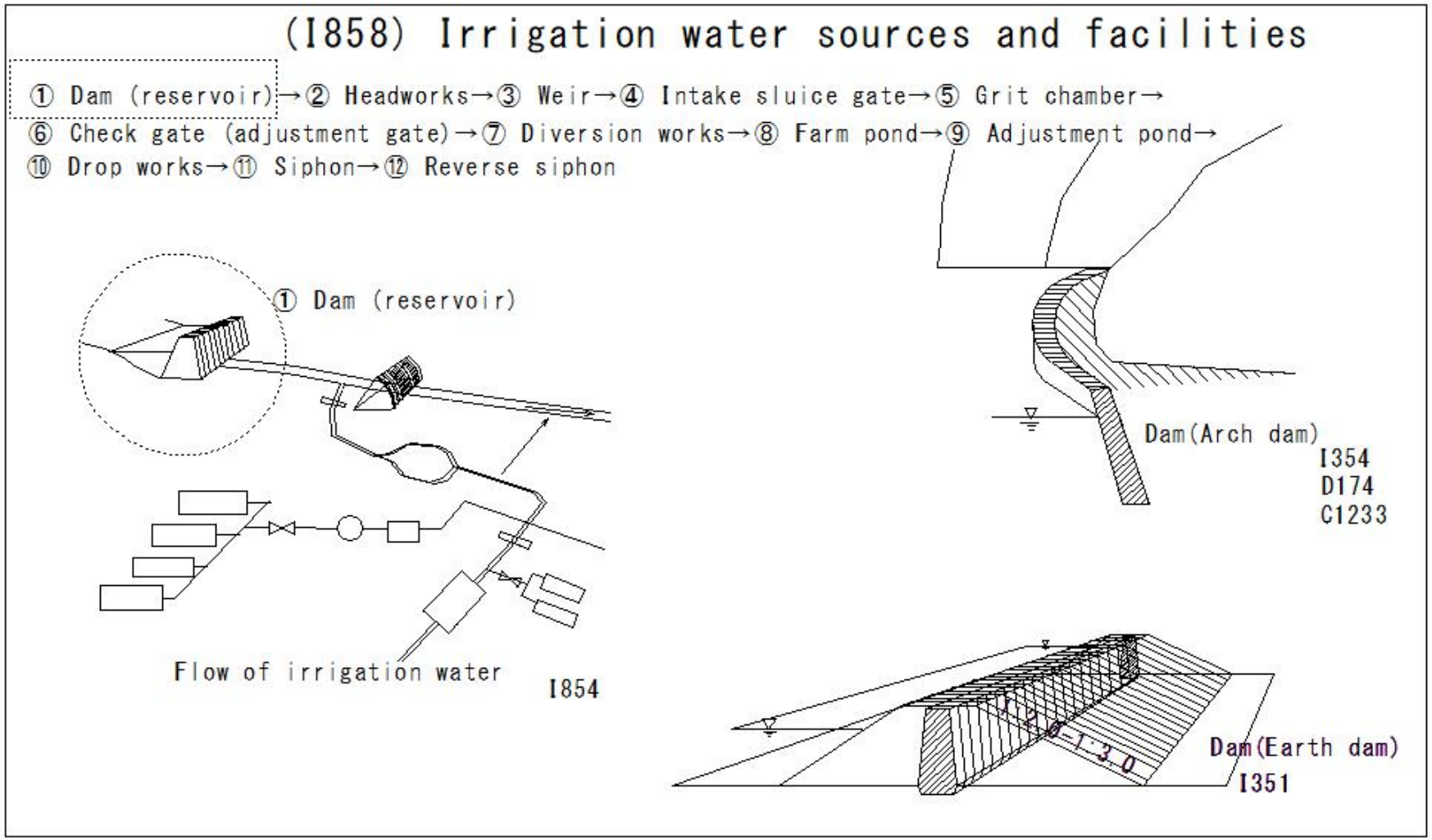
Flow of irrigation water

I854

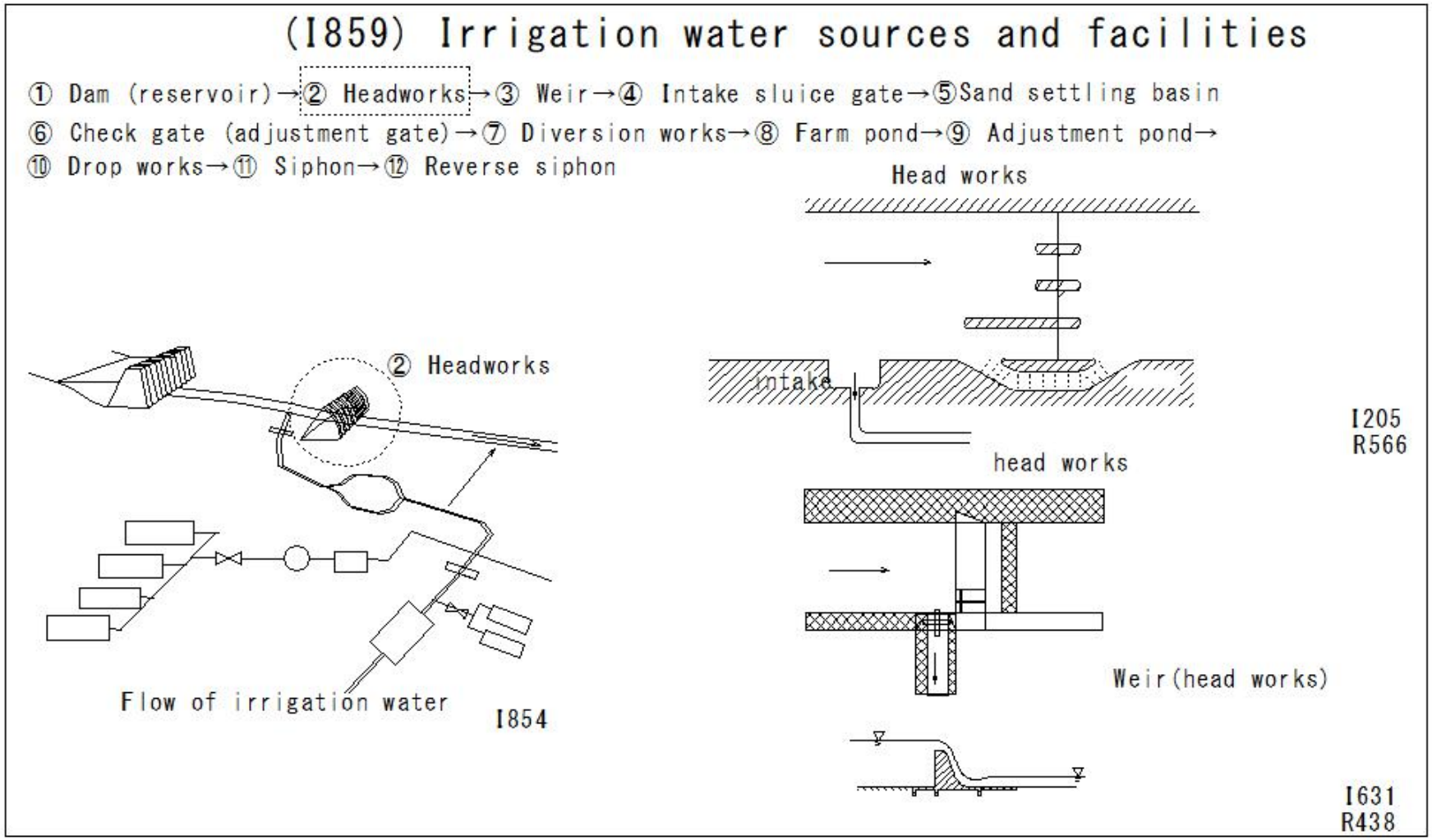
(I857) Irrigation water sources and facilities



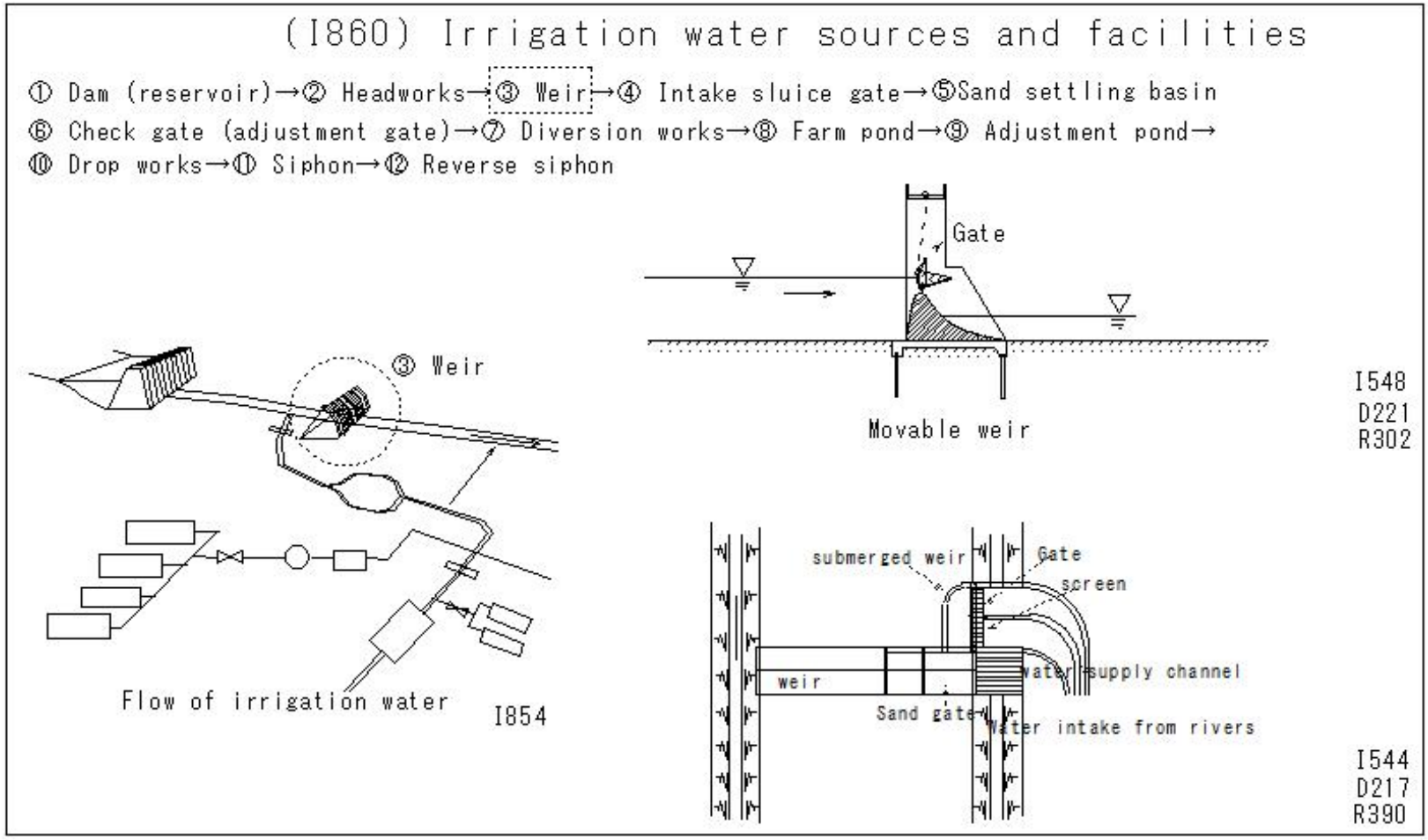
(I858) Irrigation water sources and facilities



(I859) Irrigation water sources and facilities



(I860) Irrigation water sources and facilities

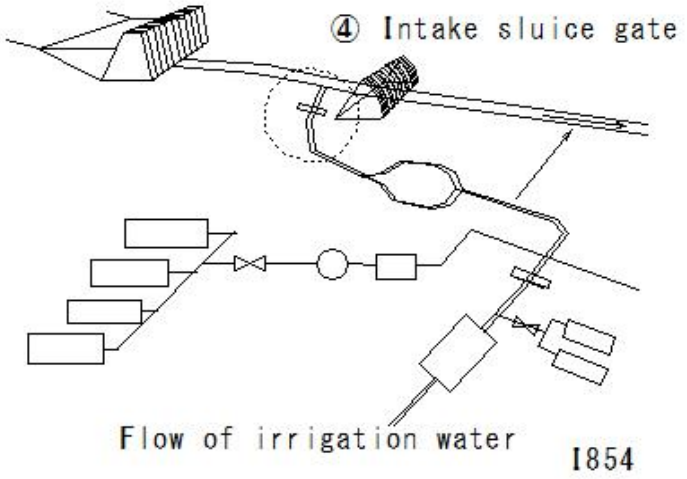


(I861)Irrigation water sources and facilities

(I861) Irrigation water sources and facilities

① Dam (reservoir)→② Headworks→③ Weir→④ Intake sluice gate→⑤Sand settling basin
⑥ Check gate (adjustment gate)→⑦ Diversion works→⑧ Farm pond→⑨ Adjustment pond→
⑩ Drop works→⑪ Siphon→⑫ Reverse siphon

Weir(head works)



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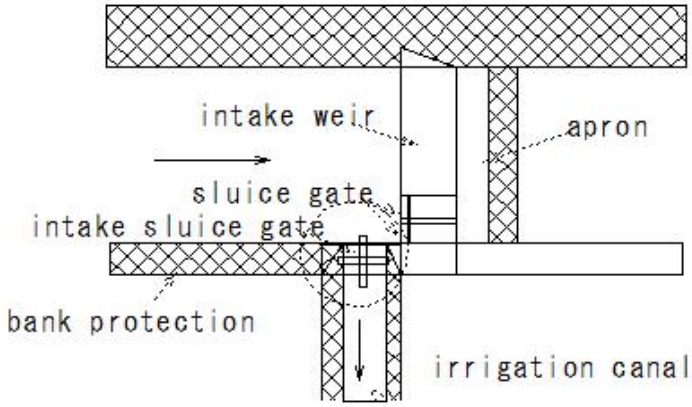
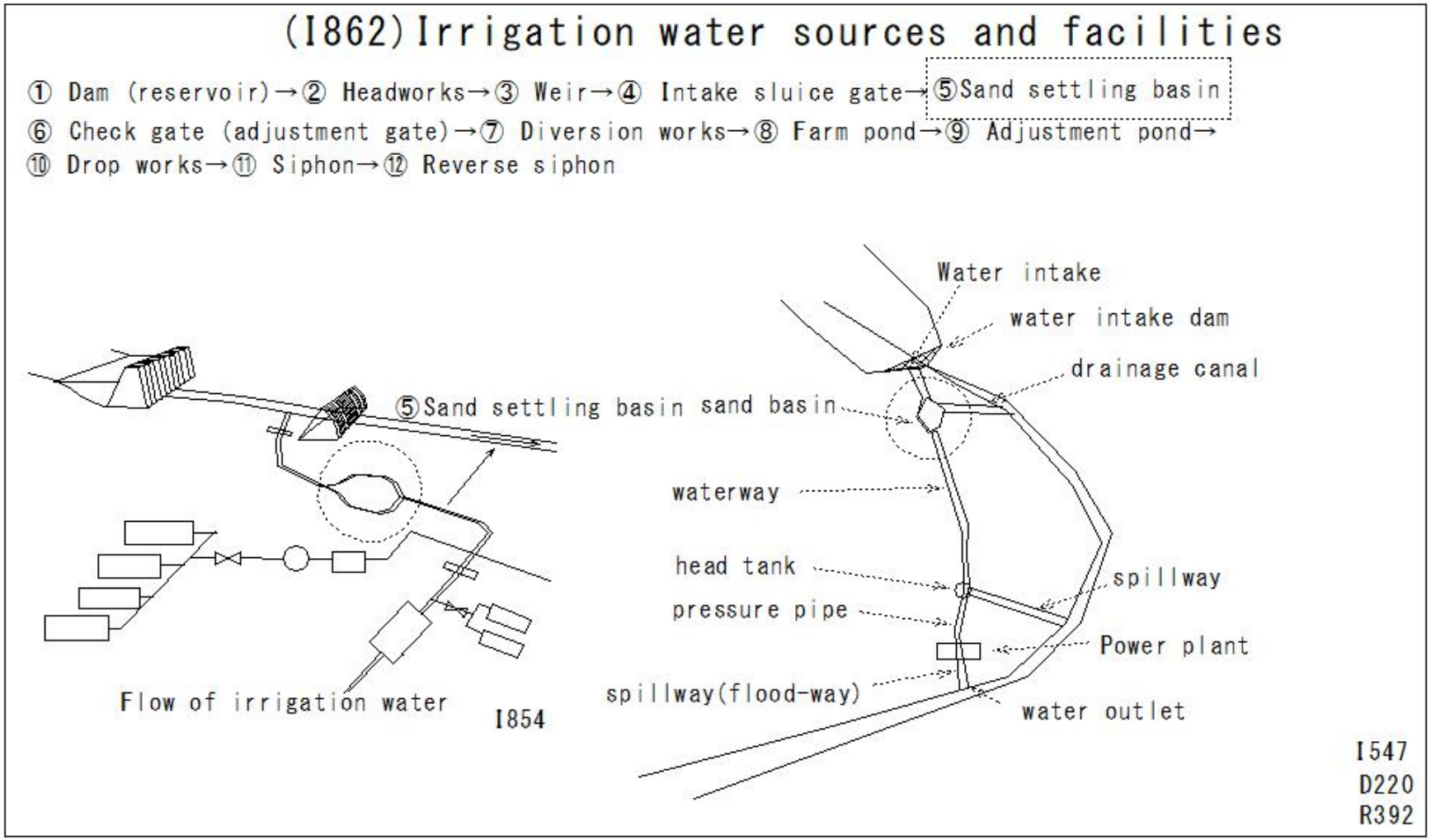
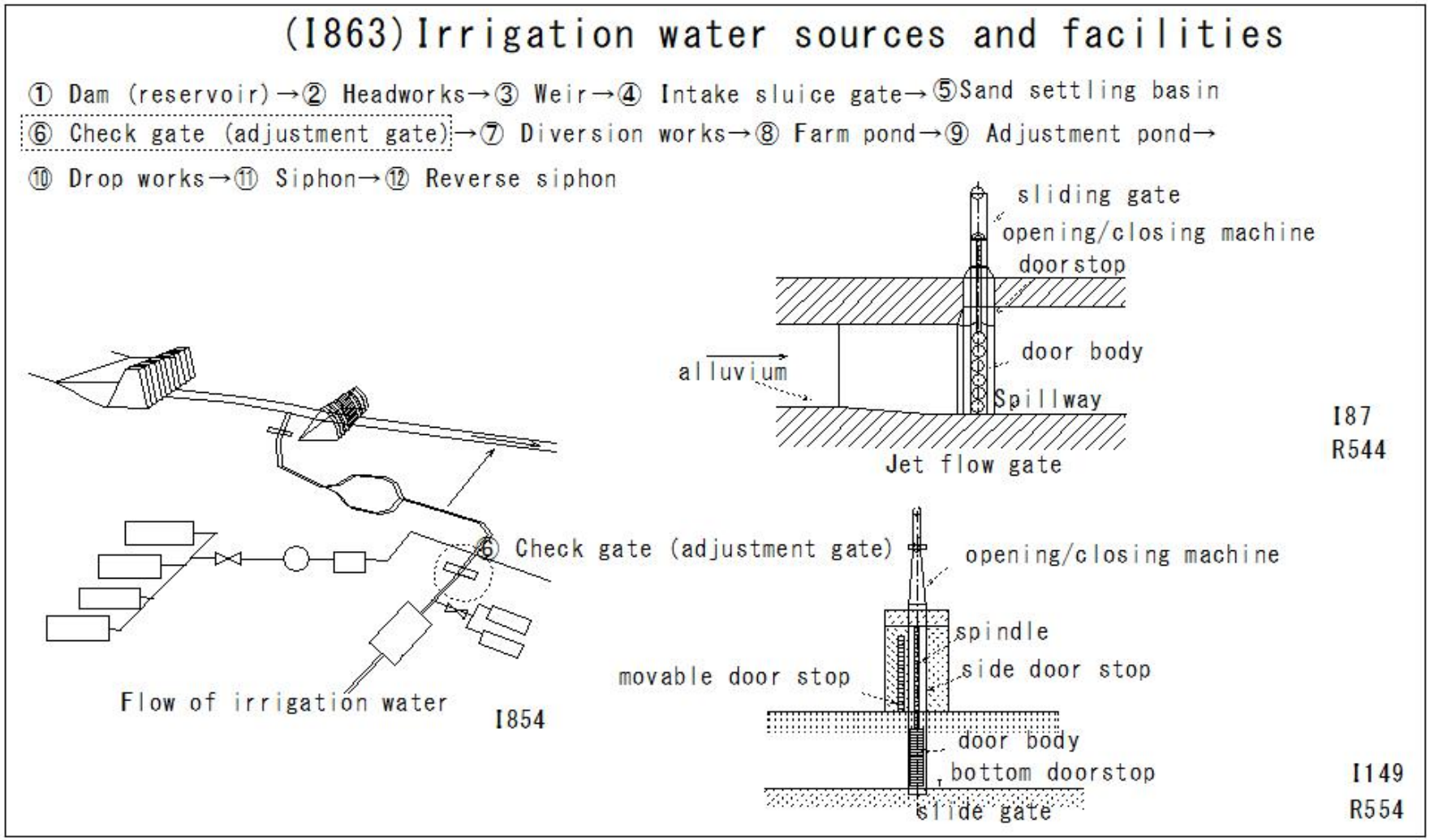


I631

(I862)Irrigation water sources and facilities



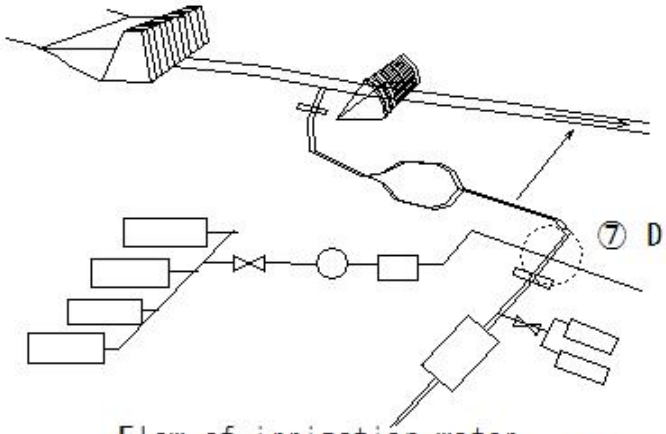
(I863)Irrigation water sources and facilities



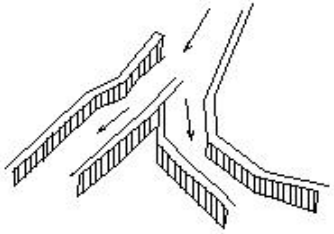
(I864)Irrigation water sources and facilities

(I864) Irrigation water sources and facilities

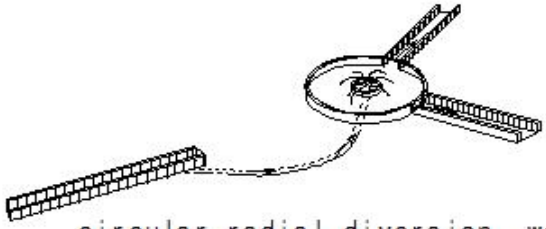
① Dam (reservoir)→② Headworks→③ Weir→④ Intake sluice gate→⑤Sand settling basin
⑥ Check gate (adjustment gate)→⑦ Diversion works→⑧ Farm pond→⑨ Adjustment pond→
⑩ Drop works→⑪ Siphon→⑫ Reverse siphon



Flow of irrigation water I854



shooting flow diversion works I737 R490

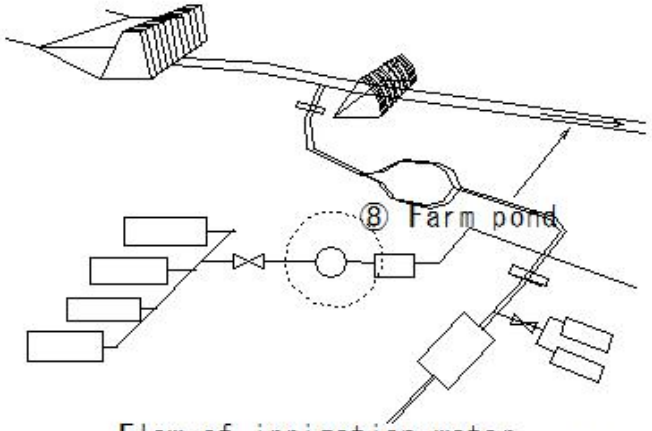


circular radial diversion works I738 R491

(I865)Irrigation water sources and facilities

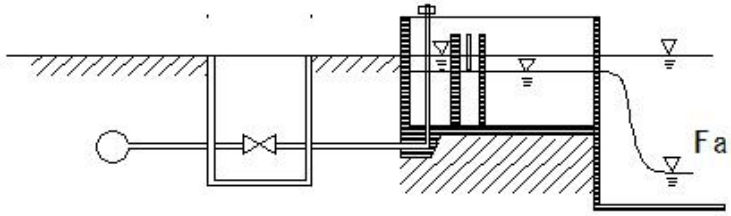
(I865)Irrigation water sources and facilities

① Dam (reservoir)→② Headworks→③ Weir→④ Intake sluice gate→⑤Sand settling basin
⑥ Check gate (adjustment gate)→⑦ Diversion works→⑧ Farm pond→⑨ Adjustment pond→
⑩ Drop works→⑪ Siphon→⑫ Reverse siphon

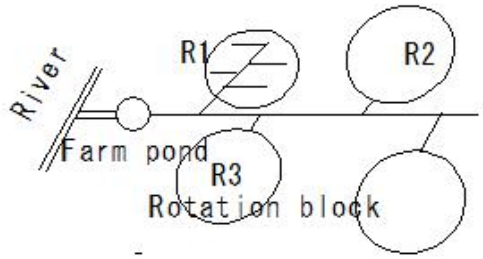


I854

Stand-type water distribution works

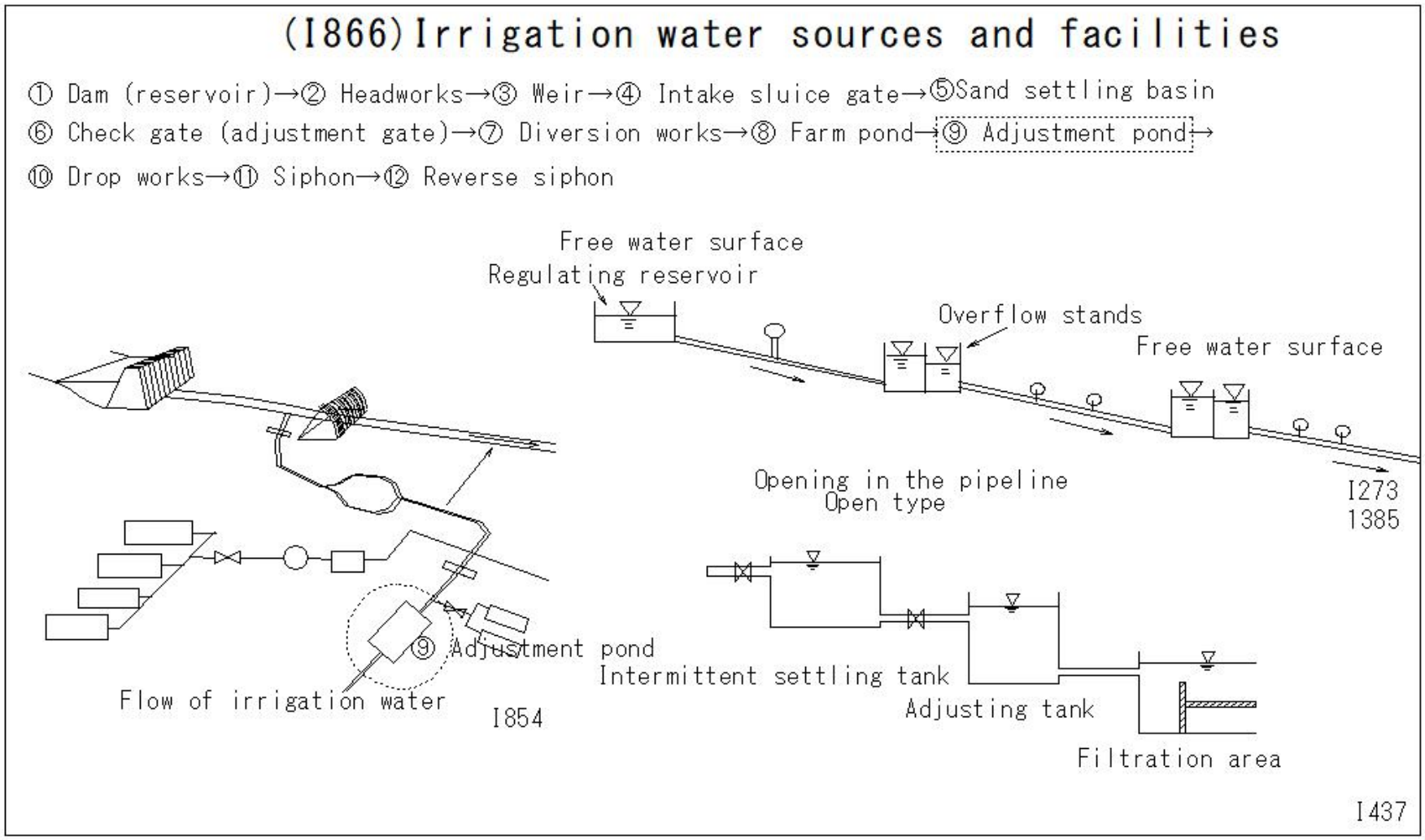


I304
1403

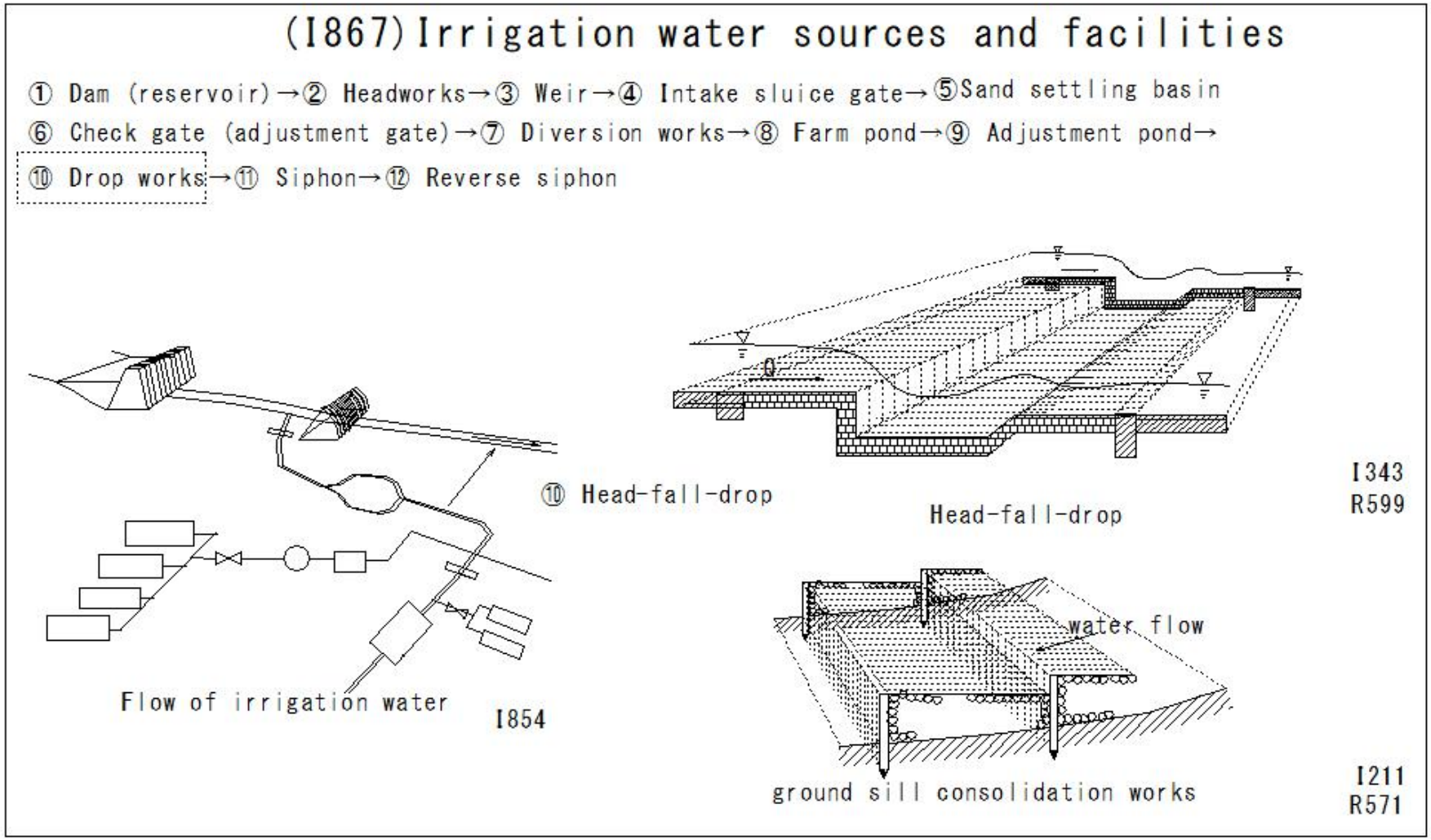


I349

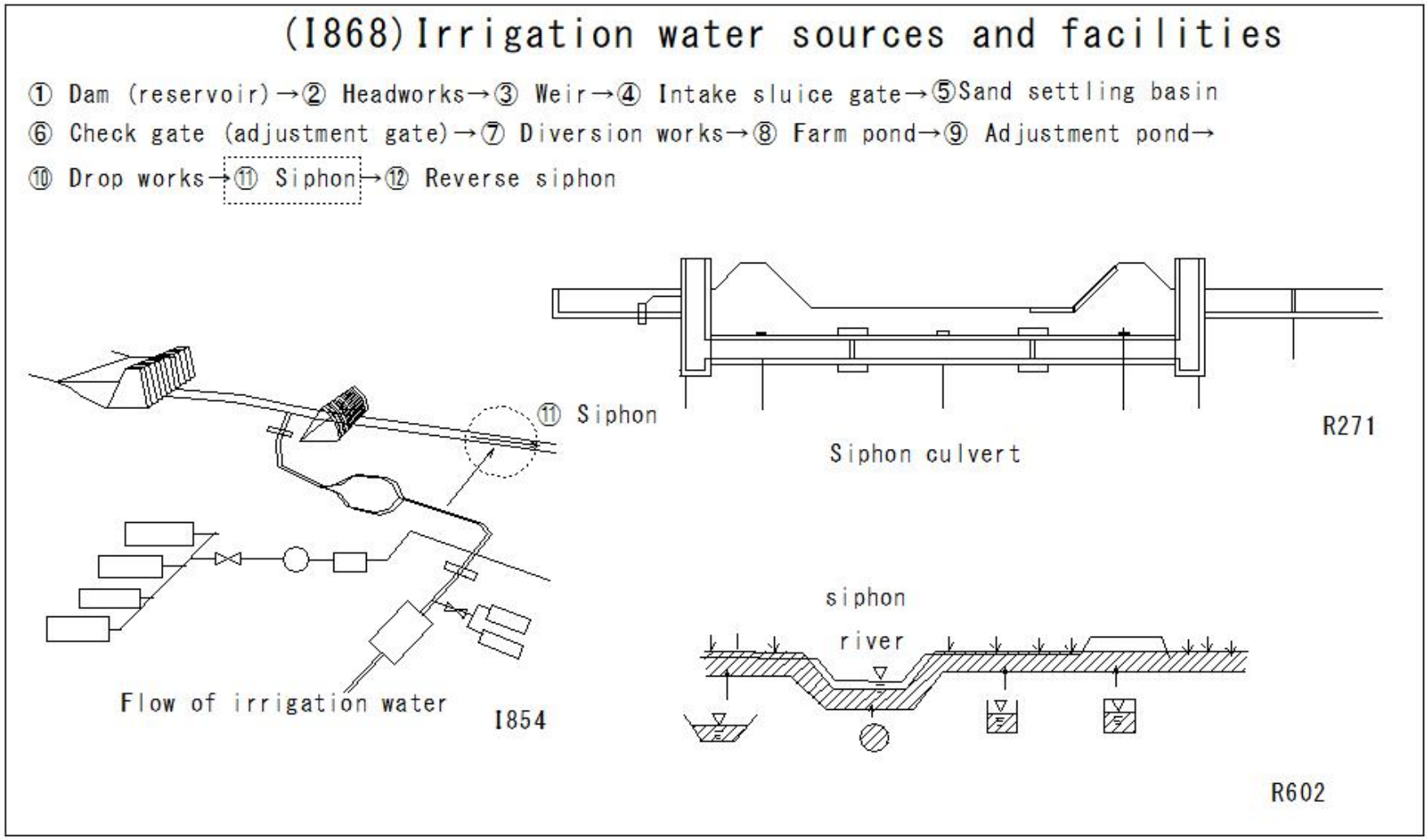
(I866)Irrigation water sources and facilities



(I867)Irrigation water sources and facilities



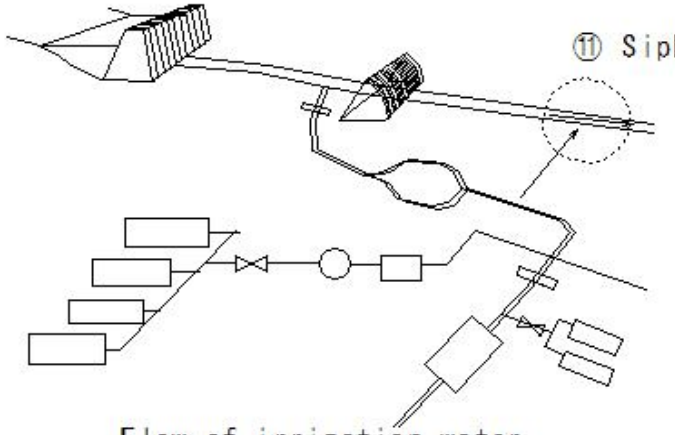
(I868)Irrigation water sources and facilities



(I869)Irrigation water sources and facilities

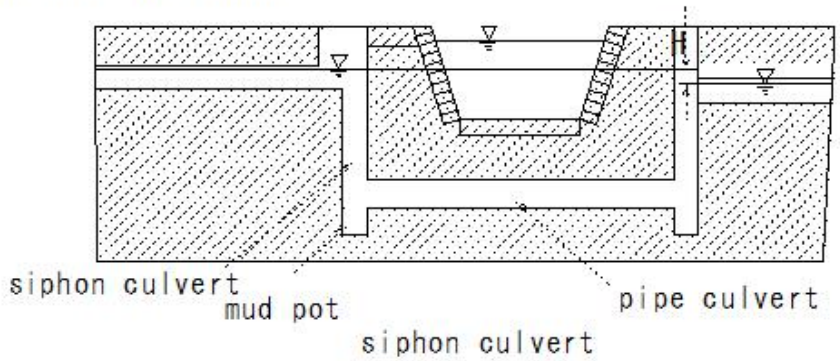
(I869) Irrigation water sources and facilities

① Dam (reservoir)→② Headworks→③ Weir→④ Intake sluice gate→⑤Sand settling basin
⑥ Check gate (adjustment gate)→⑦ Diversion works→⑧ Farm pond→⑨ Adjustment pond→
⑩ Drop works→⑪ Siphon→⑫ Reverse siphon



I854

⑪ Siphon→⑫ Reverse siphon

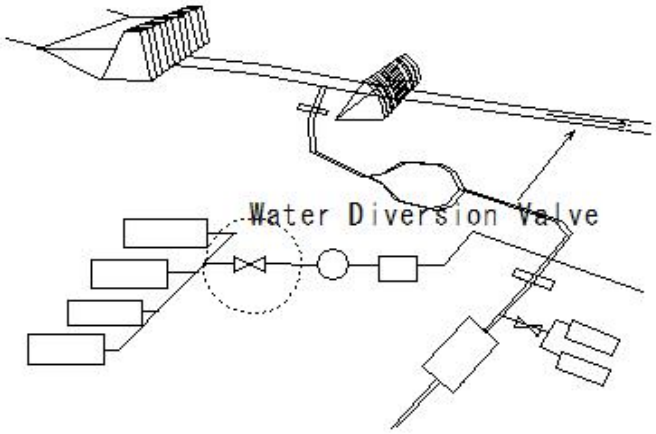


R612

(I870)Irrigation water sources and facilities

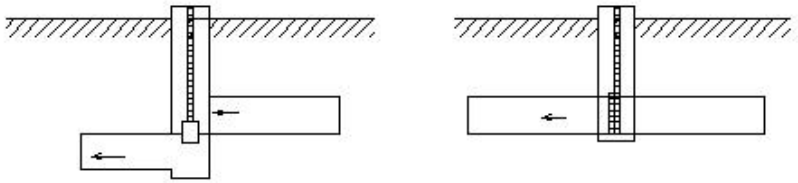
(I870)Irrigation water sources and facilities

① Dam (reservoir)→② Headworks→③ Weir→④ Intake sluice gate→⑤Sand settling basin
⑥ Check gate (adjustment gate)→⑦ Diversion works→⑧ Farm pond→⑨ Adjustment pond→
⑩ Drop works→⑪ Siphon→⑫ Reverse siphon



I854

Flow of irrigation water



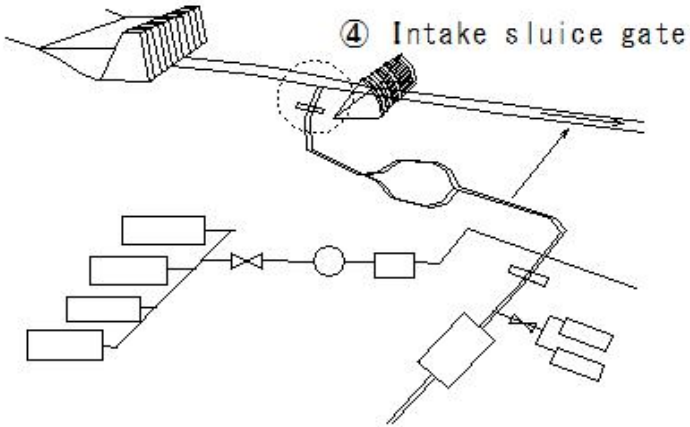
Relief well(Water gate)
Water Diversion Valve

I537
I386

(I871)Irrigation water sources and facilities

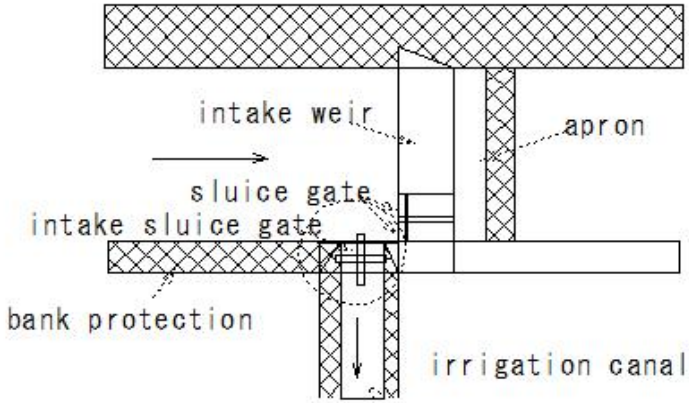
(I871)Irrigation water sources and facilities

① Dam (reservoir)→② Headworks→③ Weir→④ Intake sluice gate→⑤Sand settling basin
⑥ Check gate (adjustment gate)→⑦ Diversion works→⑧ Farm pond→⑨ Adjustment pond→
⑩ Drop works→⑪ Siphon→⑫ Reverse siphon



I854

Flow of irrigation water



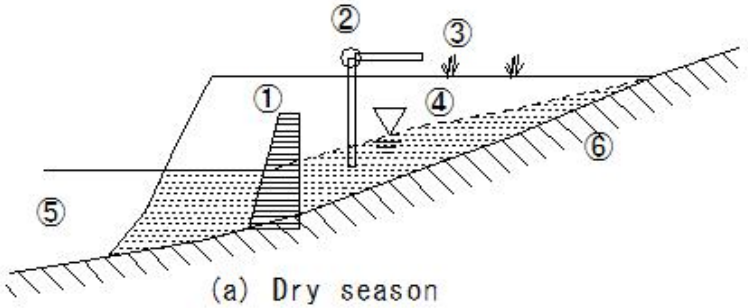
I631

(I872) Irrigation water sources and facilities

(I872) Irrigation water sources and facilities

Underground dam

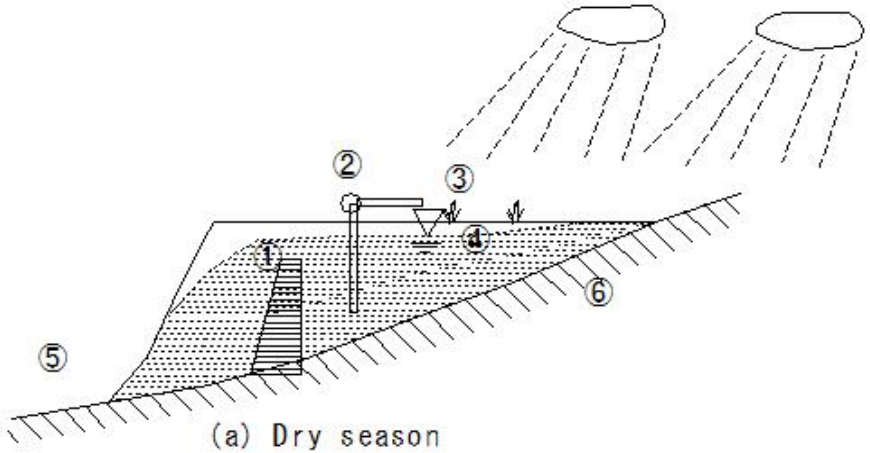
①Underground dam (water-stopping wall)
②Pump
③Field
④Groundwater level
⑤Ocean
⑥Impermeable layer
(a) Dry season



(a) Dry season

Underground dam

①Underground dam (water-stopping wall)
②Pump
③Field
④Groundwater level
⑤Ocean
⑥Sand and gravel layer
(b) Flood season



(a) Dry season

(I873) Irrigation water sources and facilities

(I873) Irrigation water sources and facilities

Underground dam

① Construction of water cutoff walls

② Storage of groundwater

③ Use of groundwater

Advantages of underground dams

④ Securing stable water resources

⑤ Rising groundwater levels

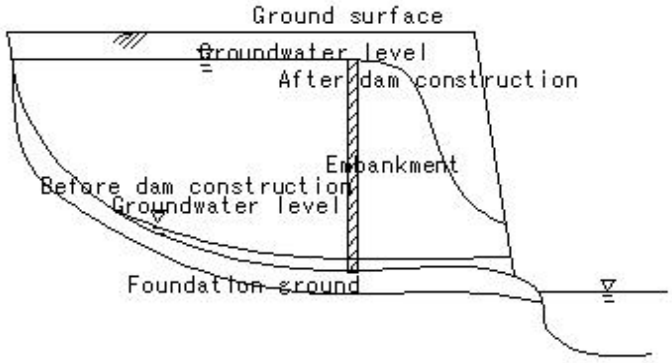
⑥ Preventing salinization:

⑦ Maintaining land use:

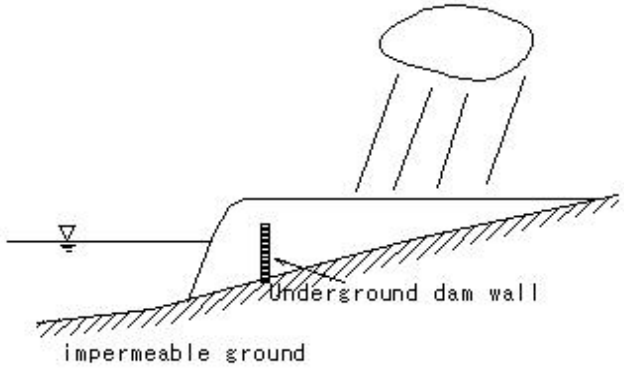
Disadvantages of underground dams:

⑧ Groundwater contamination

⑨ Construction costs: Expensive



I172
E472
R559



I219
F337

(I874)Drainage of farmland

(I874)Drainage of farmland

Drainage of farmland

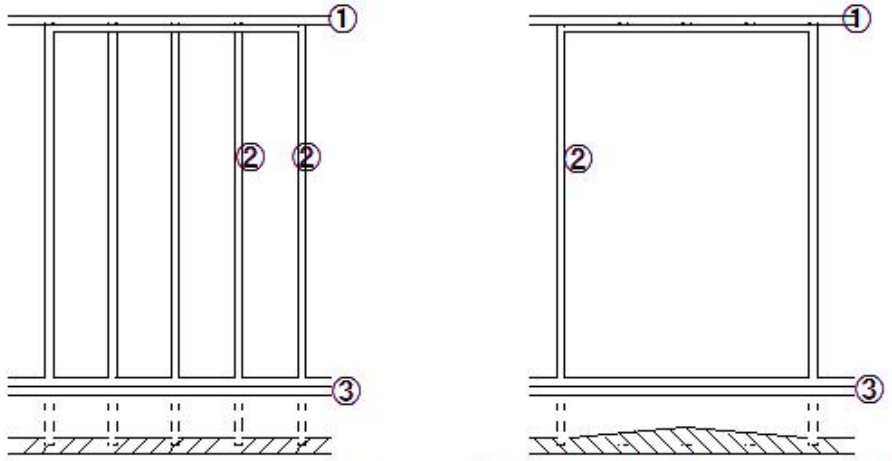
- To maintain the proper moisture environment of farmland
- To remove excess water from the surface and underground
- To improve crop growth

○To facilitate agricultural work

- Surface drainage (rice field drainage)
- To remove excess water that has accumulated on the surface of the field
- To improve soil aeration
- To dry the cultivated soil

Surface drainage (paddy fields)

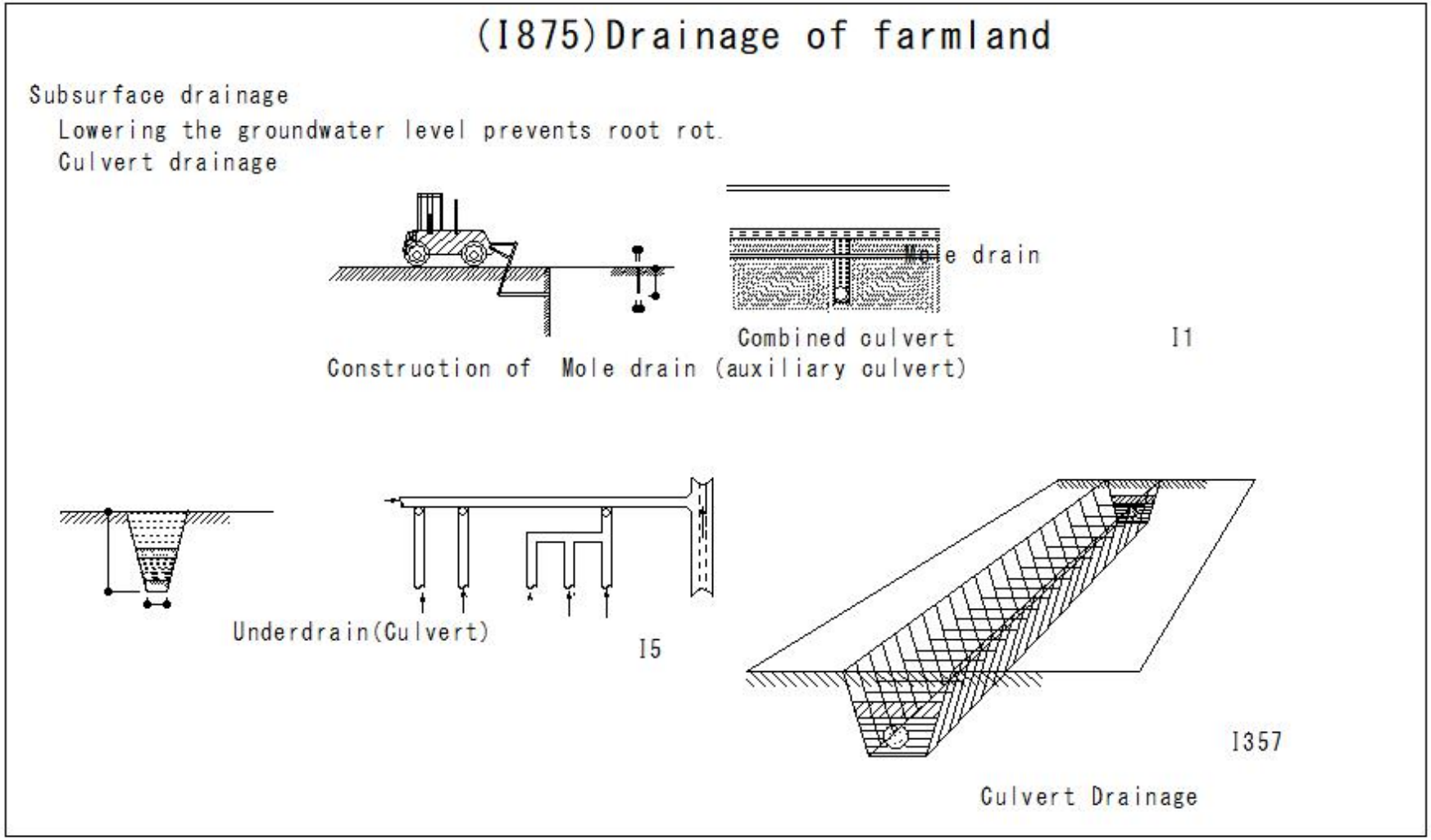
① Waterway
② Small ditch
③ Drainage channel



(Small drainage ditch) (Rice field slope method)

Surface drainage (paddy fields)

(I875)Drainage of farmland



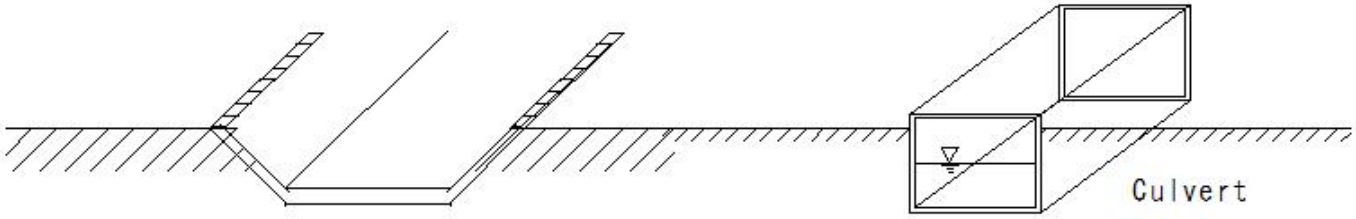
(I876)Drainage of farmland

(I876)Drainage of farmland

Drainage of farmland

Subsurface drainage: Lowering the groundwater level prevents root rot.

Open drainage



Open channel

water surface-contact with air

Channel slope - current velocity - gravity flow

Open channel

I400

(I877)Drainage of farmland

(I877)Drainage of farmland

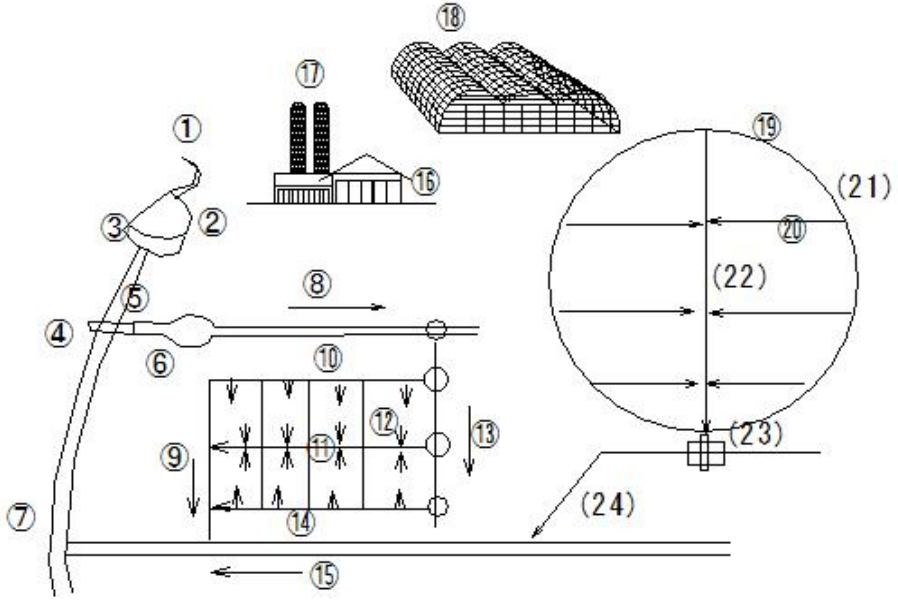
Drainage of farmland

Agricultural village drainage

①Treat livestock waste and domestic wastewater

②Drain into agricultural irrigation channels

③Prevent water pollution



Layout of farmland and various facilities

I334

(I878)Drainage of farmland

(I878)Drainage of farmland

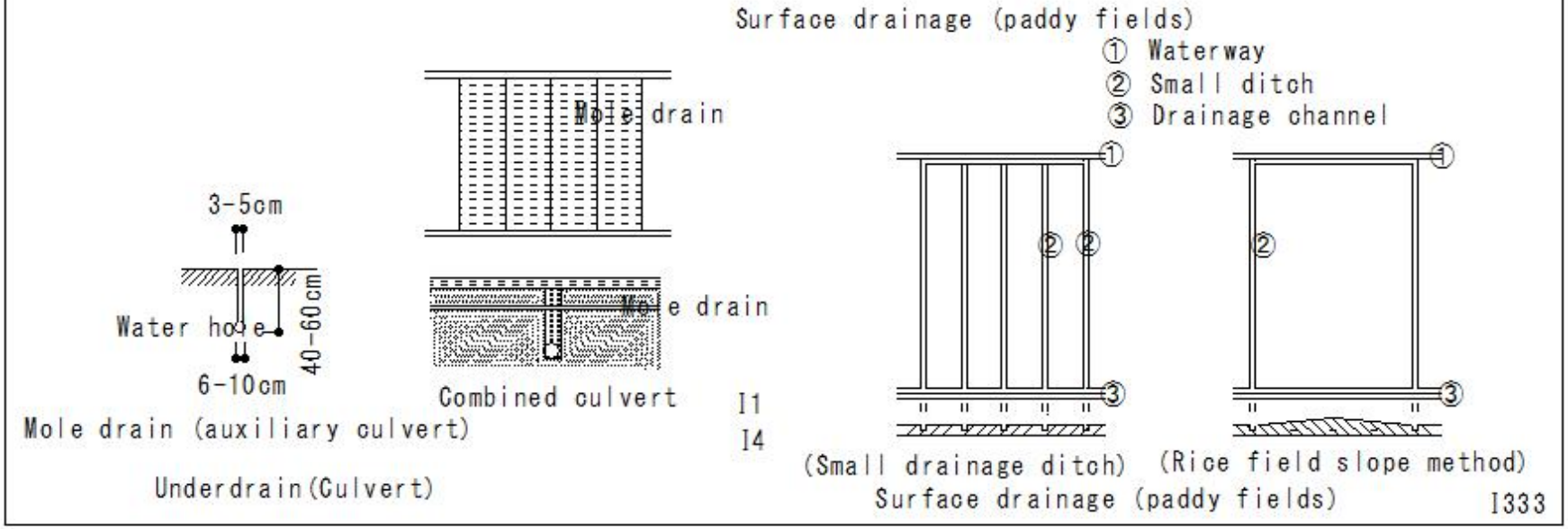
Drainage of farmland

Importance of drainage:

①Crop growth: Excessive moisture can cause root rot and the outbreak of pests and diseases.

②Agricultural work: Wet soil makes cultivation and harvesting difficult.

③Conservation of farmland: Poor drainage can cause soil erosion and salt damage.



(I879)Drainage of farmland

(I879) Drainage of farmland

Drainage of farmland

Examples of drainage measures

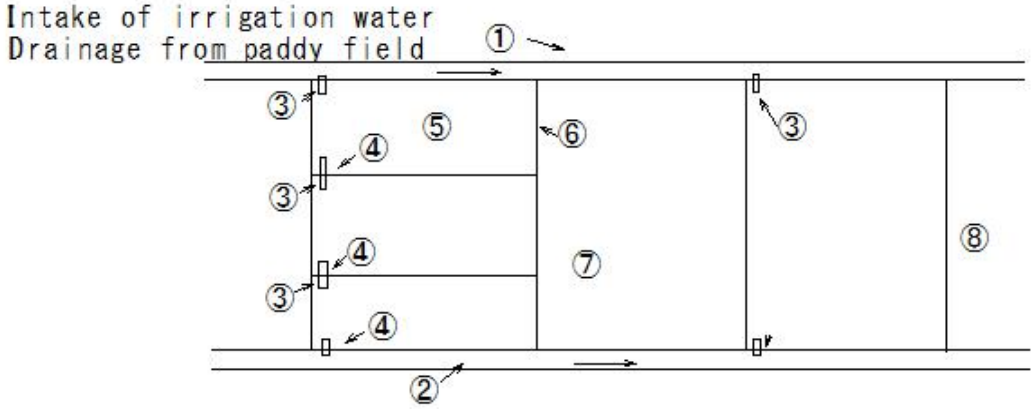
① Installation of drainage ditches and frame ditches: Digging a trench in the field to drain excess water outside.

② Use of laser levelers: Flattening the field and sloping it toward the drainage channel improves surface drainage.

③ Installation of drainage pumps: Pumping water from the drainage channel and draining it outside.

① Water channel
② Drainage channel
③ Water inlet
④ Water outlet
⑤ Paddy field
⑥ Ridge
⑦ Rice field crossing
⑧ Large paddy field

Paddy sluice-Paddy field Drainage



Water inlet and outlet

The water inlet is the place where water is drawn in, and the water outlet is the place where water is drained.

I321

(I880)Drainage of farmland

(I880)Drainage of farmland

Drainage of farmland

Key points for drainage measures

①Maintenance of drainage channels

In case of the drainage channel is clogged, drainage will be stagnant, so it is necessary to clean it regularly.

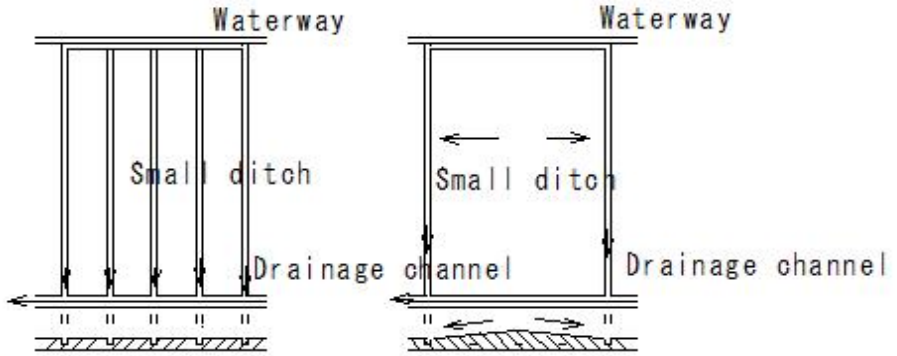
②Slope of the field

By sloping the field toward the drainage channel, drainage can be efficiently achieved.

③Selection of soil

In case of the soil has poor drainage, drainage measures must be strengthened.

Surface drainage (paddy fields)



(Small drainage ditch) (Rice field slope method)

Surface drainage (paddy fields)

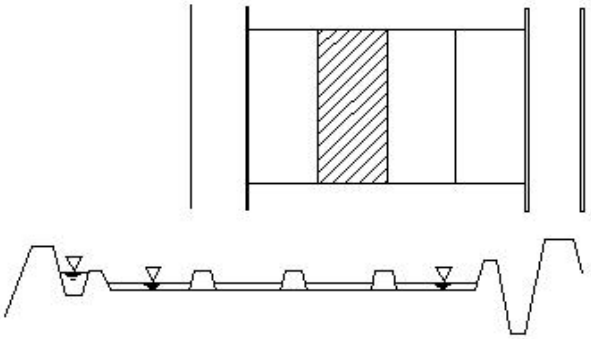
(I881)Drainage of farmland

(I881)Drainage of farmland

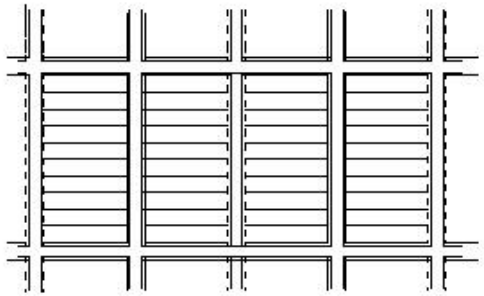
Drainage of farmland

Drying out paddy fields

① Drain paddy fields and cultivate them in a dry state
② Increase the productivity of the land
③ Improve the efficiency of paddy field management
④ Drain the water in autumn and cultivate in spring
⑤ The soil is finely kneaded and the fertility of the soil is improved
⑥ Yield increase



I353



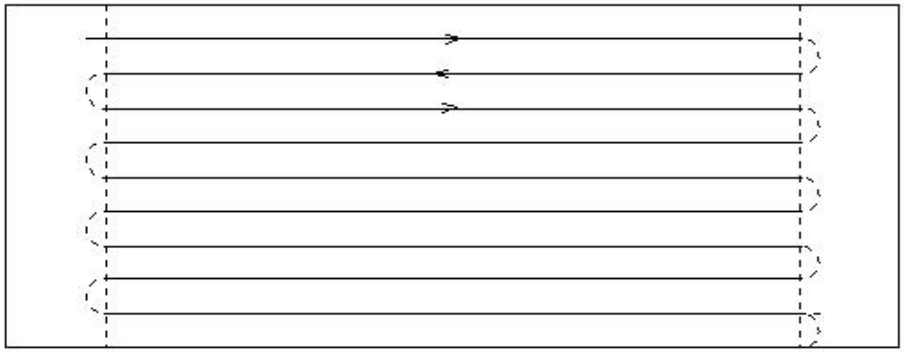
I457

Drainage of farmland

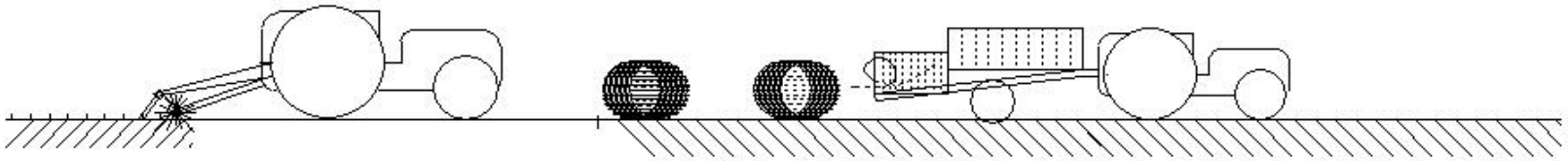
(I882)Drainage of farmland

(I882)Drainage of farmland

Drainage of farmland
Drying out fields
Improved work efficiency
Draining the fields makes it easier to mechanize, allowing the use of combines and tractors.



I318



Plowing (Puddling)

(I126)

Hay baler

I283

(I883)Drainage of farmland

(I883)Drainage of farmland

Drainage of farmland

Drying out fields

① Soil improvement

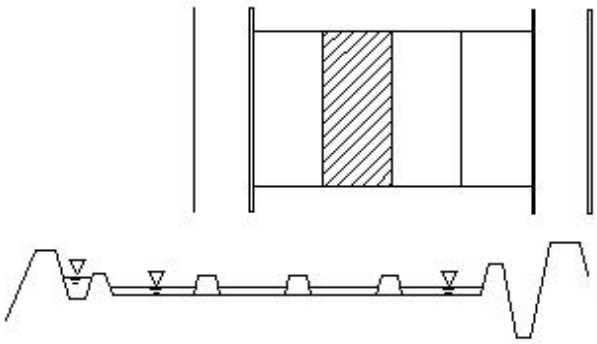
By repeatedly drying and wetting, the physical properties and drainage of the soil are improved.

② Cultivation of diverse crops:

It becomes easier to grow crops that are difficult to grow in rice paddies, such as wheat and soybeans.

③ Saving water resources:

Since there is no need to keep the soil constantly filled with water, it contributes to saving water resources more than rice paddies.



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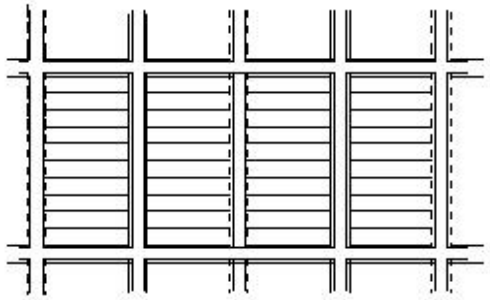


I457

Drainage of farmland

(I884)Drainage of farmland

(I884)Drainage of farmland

Drainage of farmland

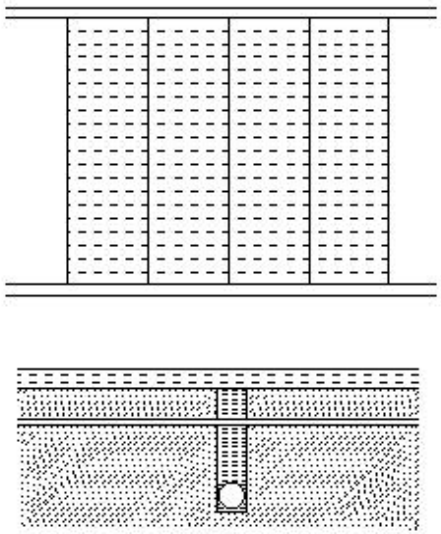
Drying out fields

Disadvantages of dry paddy fields

①Initial investment: Drainage facilities may need to be installed.

②Dry soil: Soil may dry out more easily than paddy fields.

③Weed growth: Weeds grow more easily in dry conditions.



Drying out fields

(I885)Drainage of farmland

(I885)Drainage of farmland

Drainage of farmland

Drying out fields

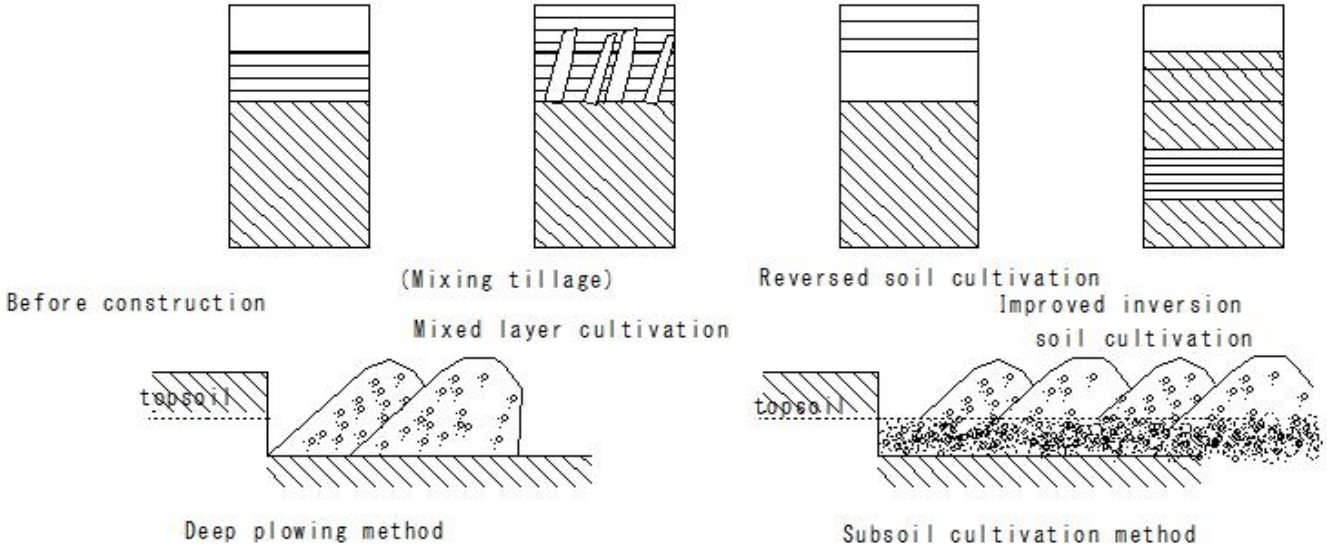
① Main methods for dry-field farming

Establishment of drainage facilities:

Install drainage ditches and drainage pumps to allow water to drain efficiently.

② Soil improvement:

To improve the physical properties and drainage of the soil, organic matter is added and deep cultivation is performed.



I78
E465

(I886)Drainage of farmland

(I886)Drainage of farmland

Drainage of farmland

Drying out fields

Dry-field direct seeding:

①This is a method of sowing seeds directly into dry rice fields, rather than flooding them after sowing.

②Dry-field direct seeding plays a role in alleviating labor shortages, water resource constraints, and reducing environmental impact.

Dry-field direct seeding:

(Small drainage ditch)　(Rice field slope method)

Surface drainage (paddy fields)

(I887)Drainage of farmland

(I887)Drainage of farmland

Drainage of farmland

Drying out fields

Paddy-field rotation

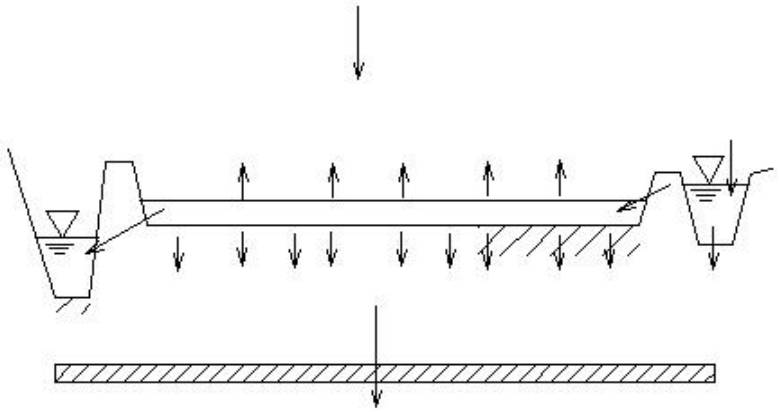
① A cultivation method in which paddy fields and fields are alternated at regular intervals

② After paddy rice cultivation, field crops (wheat, soybeans, etc.) are cultivated

③ Then the paddy fields are returned to paddy fields and the cycle is repeated

④ Promotes the diverse use of paddy fields

⑤ Maintains and improves the fertility of the land



Drying out fields

Paddy-field rotation

I837

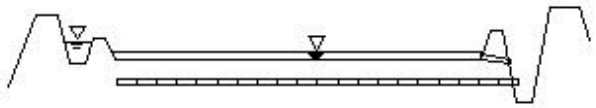
(I888)Drainage of farmland

(I888)Drainage of farmland

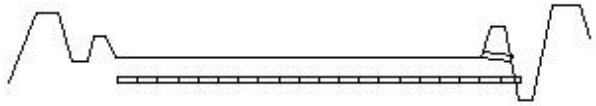
Drainage of farmland

Drying out fields

① Reduction of damage caused by continuous cropping
② Suppression of weeds
③ Improvement of soil physical properties
④ Utilization of soil nutrients
⑤ Increased rice yield



Paddy fields



Fields

Rice-field rotation
Drainage of farmland

(I889)Drainage of farmland

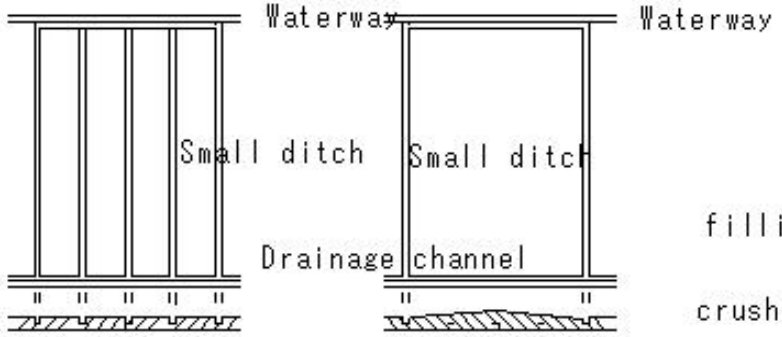
(I889)Drainage of farmland

Drainage of farmland

Field drainage

① This is the process of draining excess water from a field to improve crop growth and the soil environment.

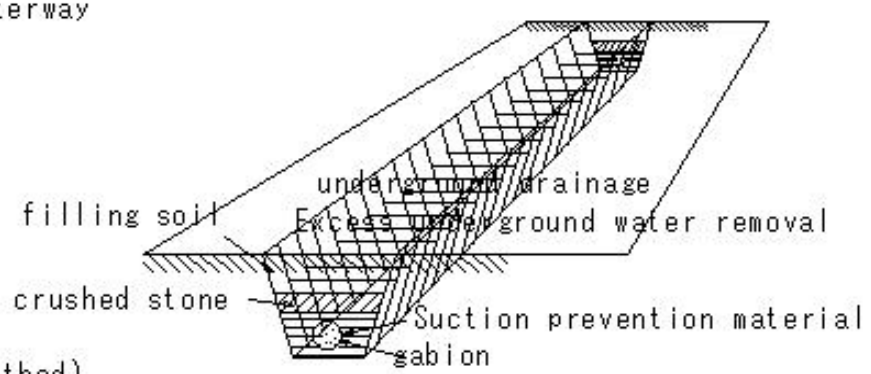
② There are two main types: surface drainage and subsurface drainage.



(Small drainage ditch)

(Rice field slope method)

Surface drainage (paddy fields)



Subsurface drainage.
Underground drainage

I333

I357

(I890)Drainage of farmland

(I890)Drainage of farmland

Drainage of farmland

Field drainage

1. Surface drainage:

Purpose:

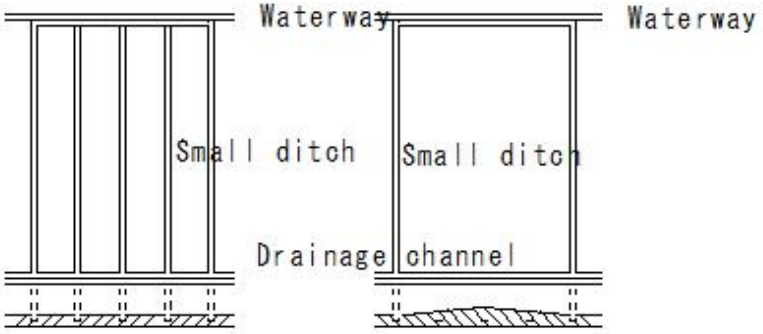
To quickly remove water that has accumulated on the surface of the field, prevent root rot of crops, and improve workability.

Method:

Open drainage: Digging a trench around or inside the field to drain water.

Laser leveler: Flattening the field and sloping it toward the drainage channel.

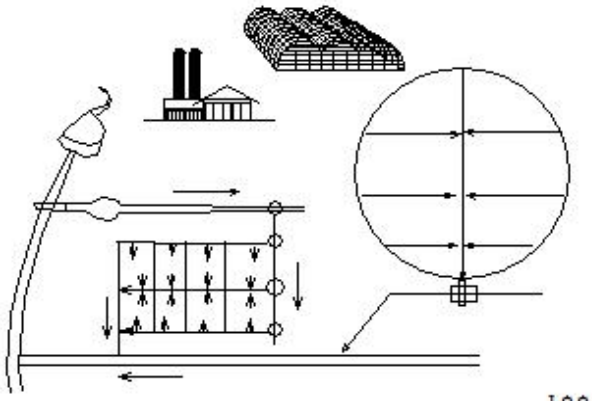
Framed open drainage: Digging a trench around the field to collect and drain water.



(Small drainage ditch) (Rice field slope method)

Surface drainage (paddy fields)

I333



I334

(I891)Drainage of farmland

(I891)Drainage of farmland

Drainage of farmland

Field drainage

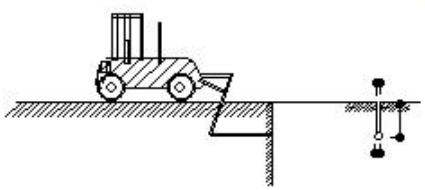
2. Underground drainage:

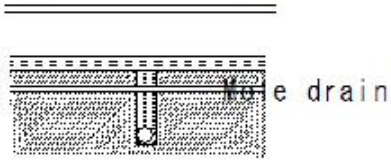
Purpose: To drain moisture from the soil underground.

Method:

Culvert: Bury a pipe underground to drain water underground.

Vertical hole drainage: Destroy the tilled layer to improve drainage.

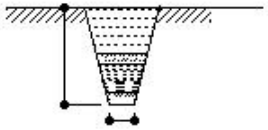


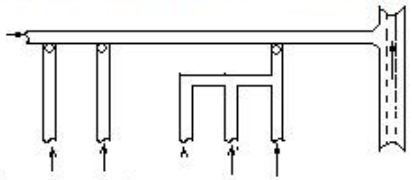


Combined culvert

I1

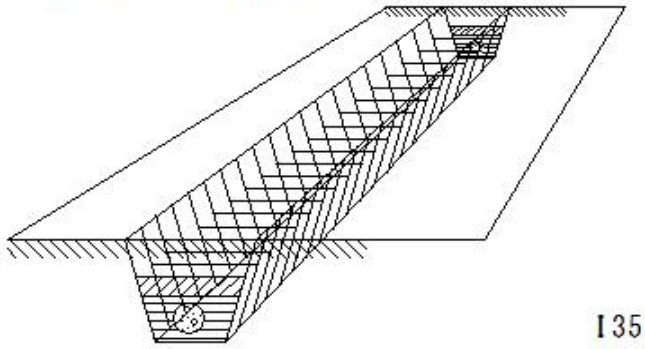
Construction of Mole drain (auxiliary culvert)





Underdrain(Culvert)

I5



I357

(I892) Drainage method

(I892) Drainage method

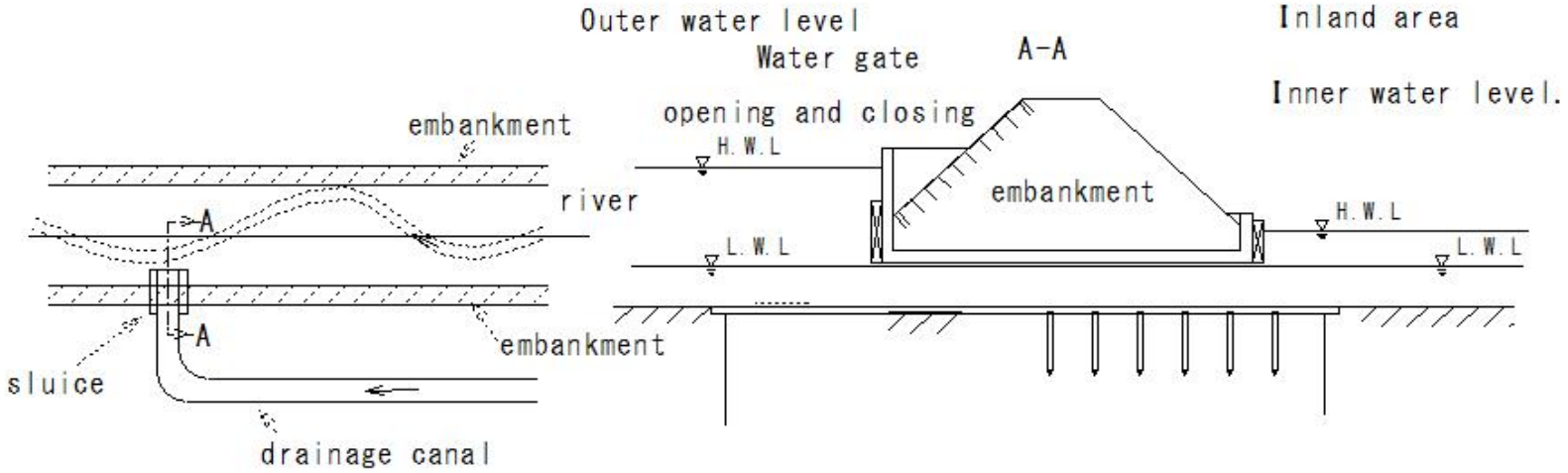
Drainage method

①Natural drainage

Natural drainage is a method of draining water so that it flows naturally downstream.

②Mechanical drainage

Mechanical drainage is a system in which pumps or other machines are used to raise the wastewater upstream when it is difficult to drain it by natural gravity alone.



sluice-sluice pipe

Structure of sluice-sluice pipe

R143

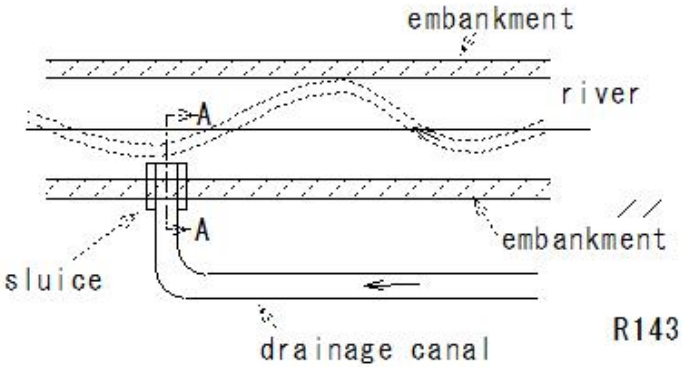
(I893) Drainage method

(I893) Drainage method

Drainage method

①Natural drainage

Natural drainage is a method of draining water so that it flows naturally downstream.



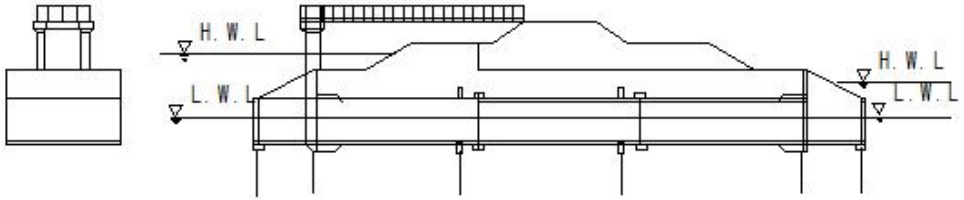
R143

sluice-sluice pipe

①Natural drainage

Outer water level < Inner water level.

opening



R270

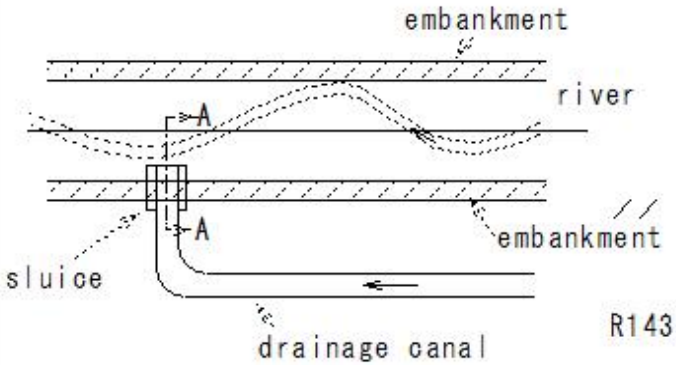
Structure of sluice-sluice pipe

(I894) Drainage method

(I894) Drainage method

Drainage method

Mechanical drainage is a system in which pumps or other machines are used to raise the wastewater upstream when it is difficult to drain it by natural gravity alone.



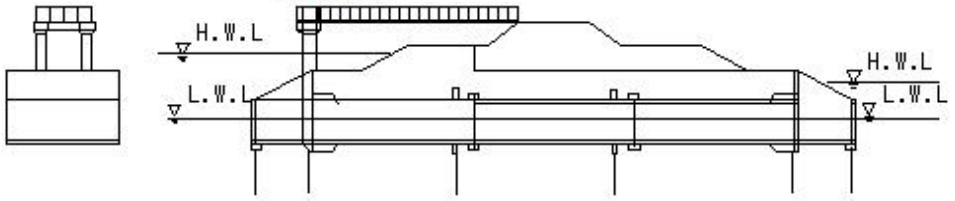
R143

sluice-sluice pipe

②Mechanical drainage

Outer water level > Inner water level.

closing

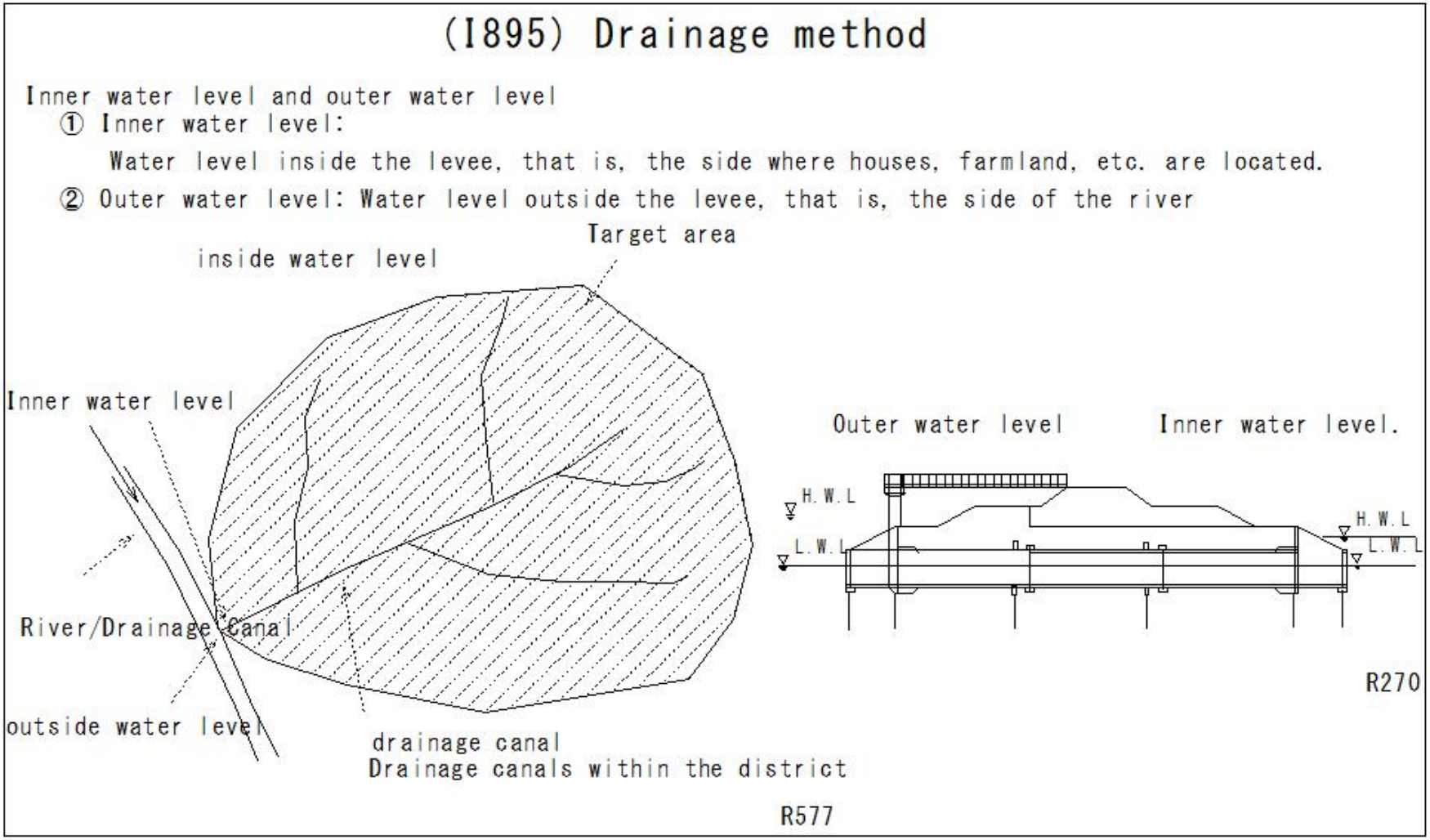


Water gate

R270

Structure of sluice-sluice pipe

(I895) Drainage method



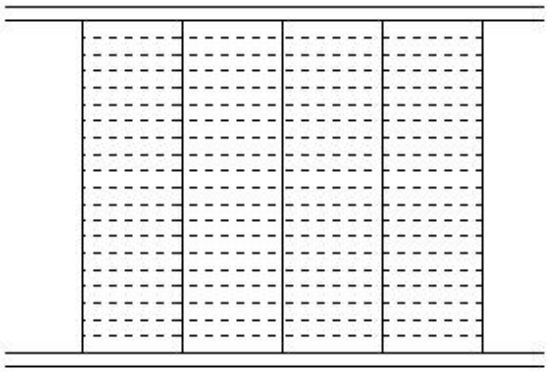
(I896) Underdrainage

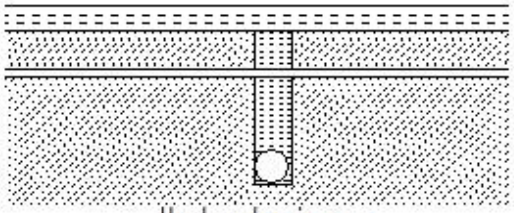
(I896) Underdrainage

Underdrainage

① Underdrainage is one of the measures to turn paddy fields into dry fields when necessary.

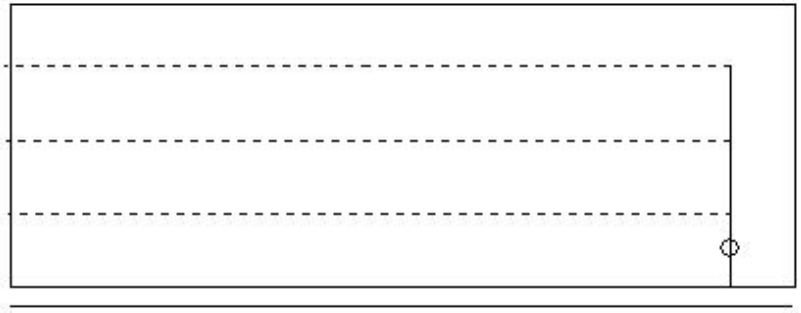
② Underdrainage is a method to effectively remove excess water by creating a continuous underground water space to lower the residual water on the surface and the groundwater level.

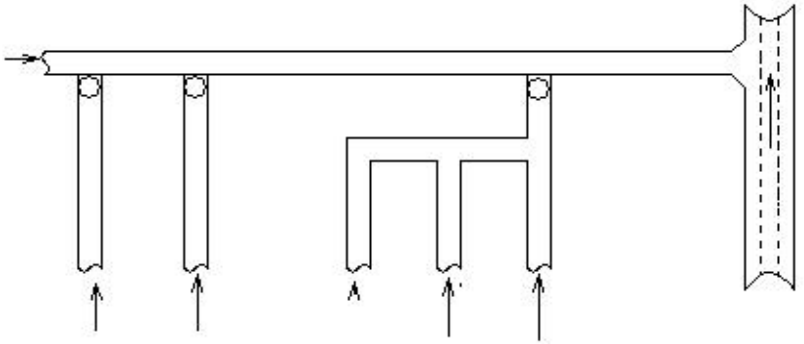




Underdrainage
Combined culvert

I1





Layout diagram of culvert

I2

(I897) Underdrainage

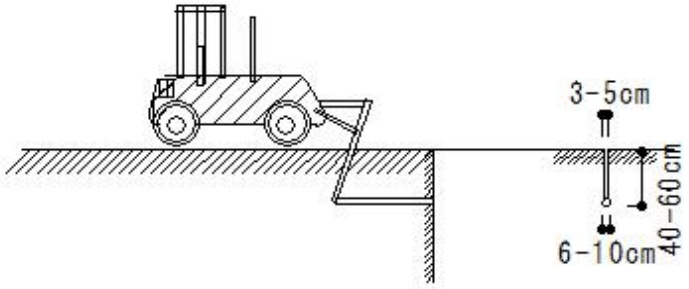
(I897) Underdrainage

Benefits of underdrainage

①Improved drainage:
Because water is less likely to stagnate underground, this prevents root rot and promotes plant growth.

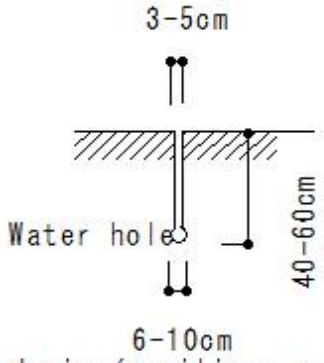
②Lowering the groundwater level:
Lowering the groundwater level also helps stabilize the ground and protect building foundations.

③Promoting land use:
Land that was previously difficult to use due to poor drainage can now be used with underdrainage.



Construction of Mole drain (auxiliary culvert)

I3



Mole drain (auxiliary culvert)

I4

(I898) Underdrainage

(I898) Underdrainage

Disadvantages of underground drainage

④ Initial cost:

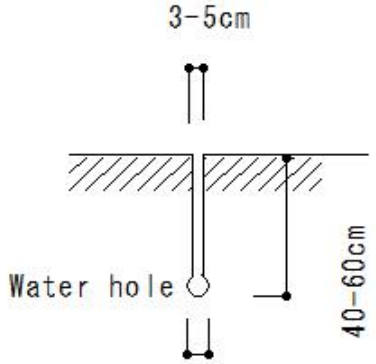
Laying pipes underground costs a certain amount of money.

⑤ Maintenance:

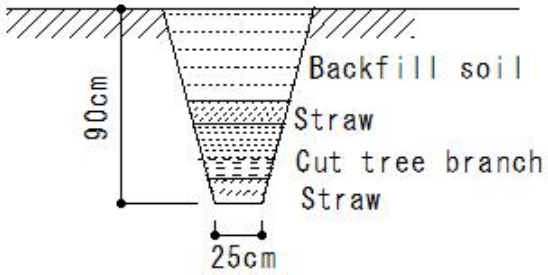
Because underground drains are underground, inspection and repair are difficult, and excavation work is required if problems such as clogging occur.

⑥ Difficulty of construction:

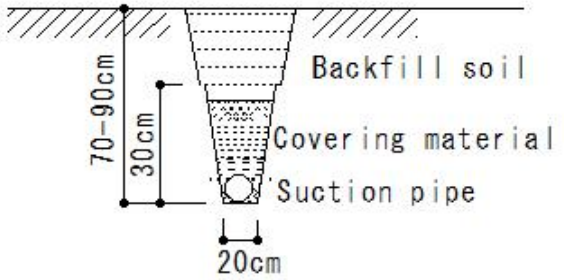
Since specialized knowledge and skills are required, it may be difficult to construct them



Mole drain (auxiliary culvert)



Simple culvert



Complete culvert

I4 I5 I6

(I899) Underdrainage

(I899) Underdrainage

How underdrain drainage works

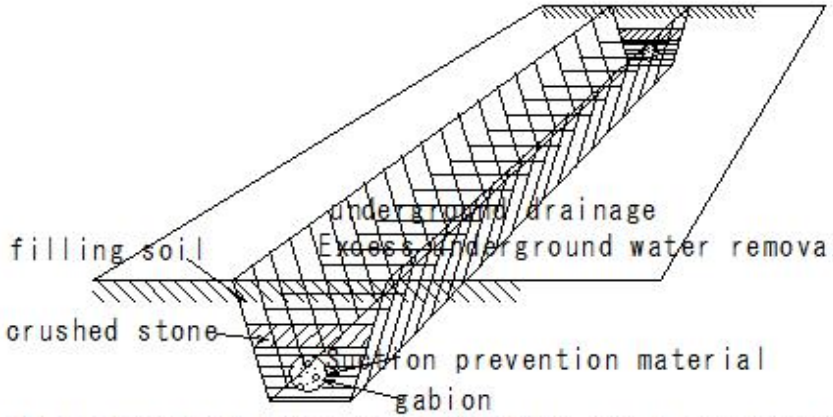
⑦Excavating the drainage channel: Dig a drainage channel underground.

⑧Laying permeable sheet: Cover the bottom and sides of the drainage channel with permeable sheet to prevent the soil from directly touching the pipe.

⑨Laying the underdrain pipe: Lay the perforated underdrain pipe on top of the permeable sheet to give the drainage channel a slope.

⑩Laying crushed stone, etc.: Lay crushed stone, etc. around the underdrain pipe to increase permeability.

⑪Backfilling: Backfill with excavated soil and smooth the surface.



E496
I357

Culvert drainage is a method of improving drainage of land by using underground waterways (culverts).

(I900) Underdrainage

(I900) Underdrainage

Applications of underdrainage

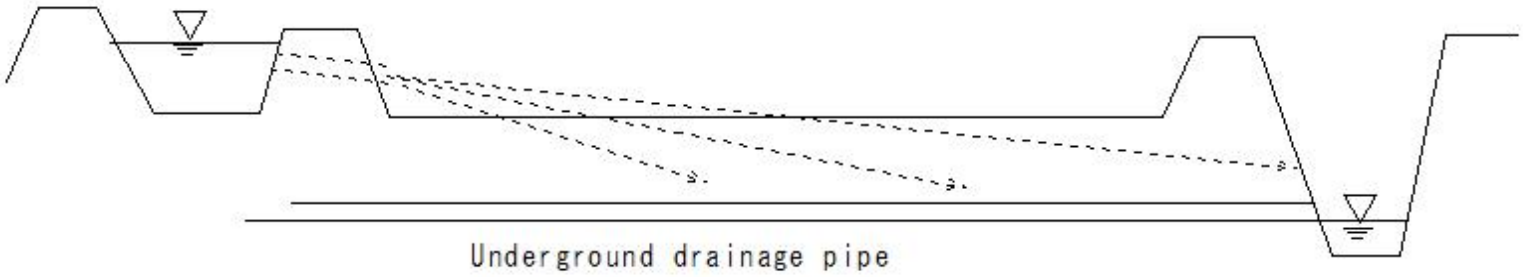
⑫ Farmland: Improves drainage to promote the growth of field crops.

⑬ Paddy fields and fields: Improves gardens that are suffering from poor drainage.

⑭ Used as a drainage measure when spring water occurs in paddy fields and fields.

⑮ Improves drainage in paddy fields and fields.

⑯ Paddy fields and fields: Prevents landslides and stabilizes cultivated soil.



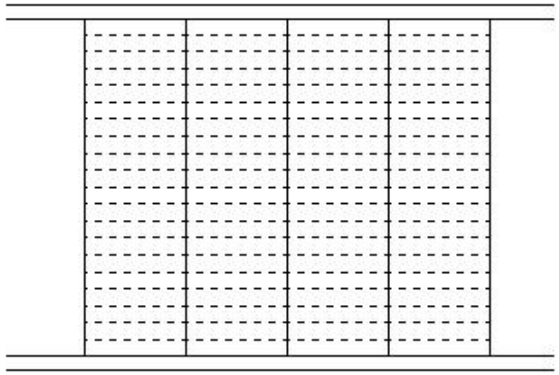
I525

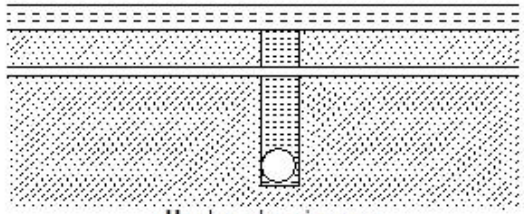
(I901) Underdrainage

(I901) Underdrainage

Depth and spacing of underdrainage

①Soil type	⑤Depth of underdrain (m)	⑥Spacing of underdrain (m)
②Sandy soil	1.20	20～24
③Loam soil	1.30	14～20
④Clay layer	1.40～1.60	10～14





Underdrainage
Combined culvert

I1

(I902) Underdrainage

(I902) Underdrainage

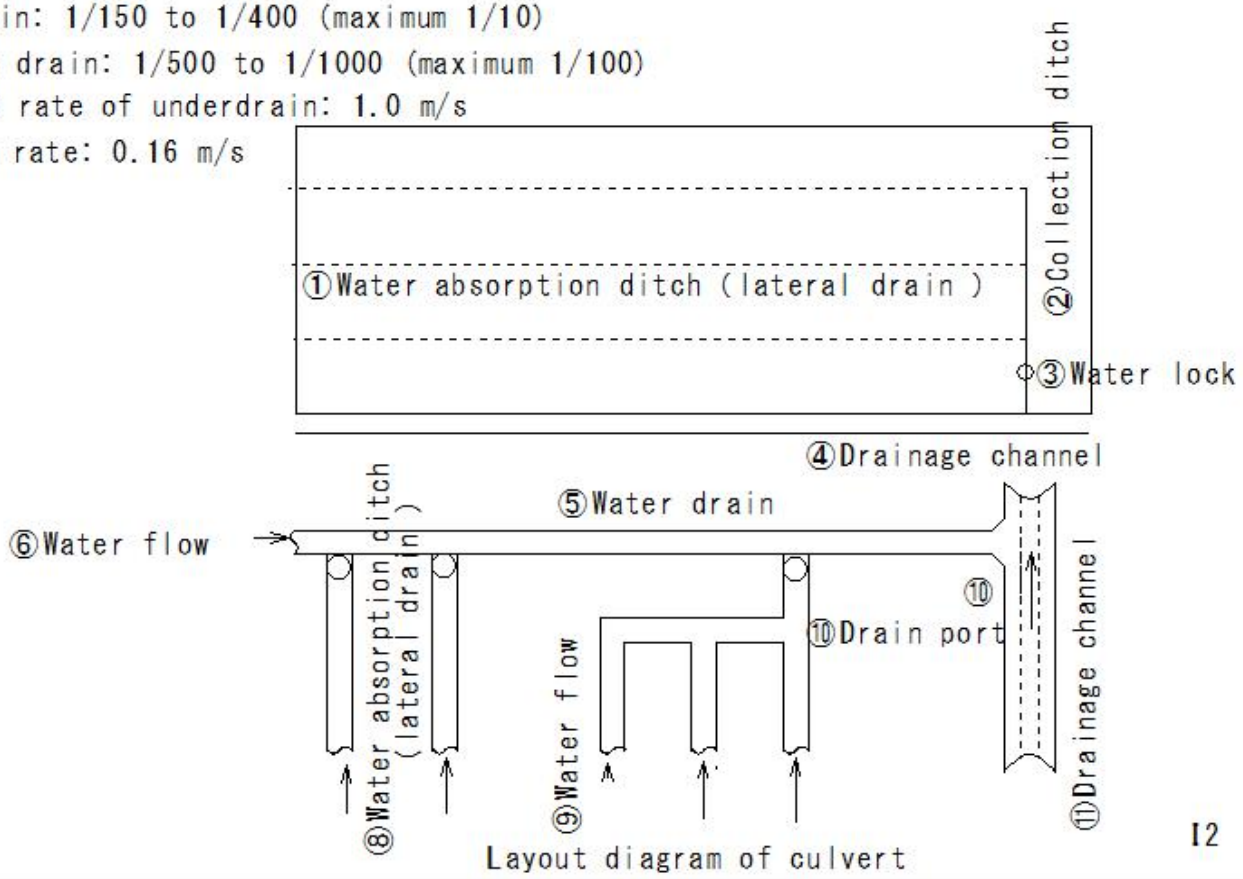
Gradient and flow rate of underdrain drainage

①Gradient of intake drain: 1/150 to 1/400 (maximum 1/10)

②Gradient of collection drain: 1/500 to 1/1000 (maximum 1/100)

③Maximum allowable flow rate of underdrain: 1.0 m/s

④Minimum allowable flow rate: 0.16 m/s



Layout diagram of culvert

I2

(I903) Drainage facilities

(I903) Drainage facilities

Layout of drainage facilities

①Drainage sluice gate

②Drainage pumping station

③Forest behind

④Waterway (Receiving waterway)
Diversion ditch) (Intake channel) Intake channel

⑤High-level farmland

⑥Natural drainage basin

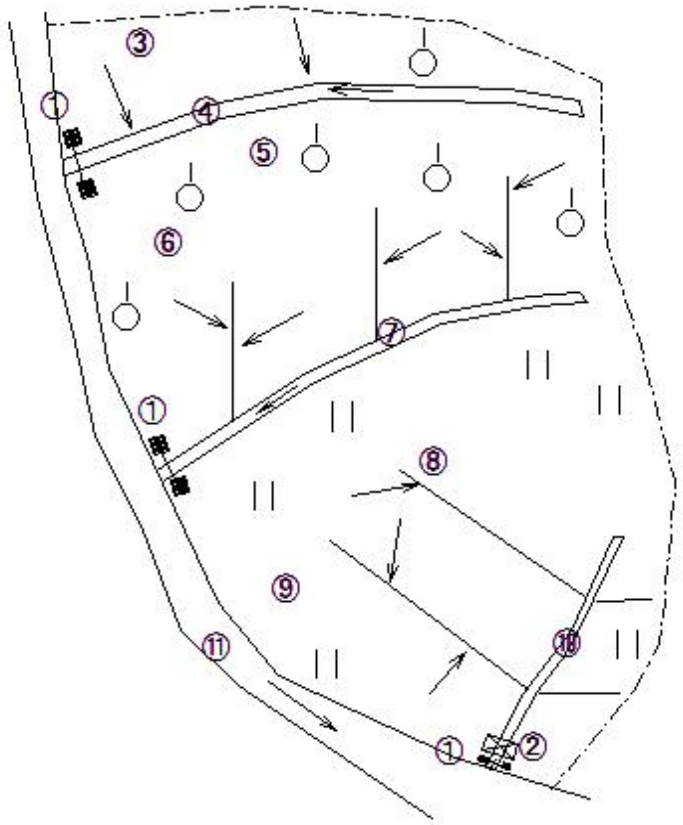
⑦High-level drainage channel

⑧Bottom-level farmland

⑨Mechanical drainage basin

⑩Bottom-level drainage channel

⑪Drainage river



Layout of drainage facilities

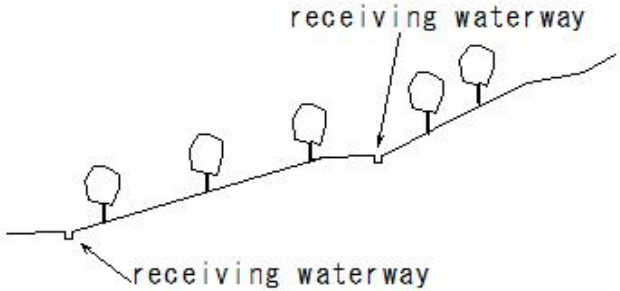
(I904) Drainage facilities

(I904) Drainage facilities

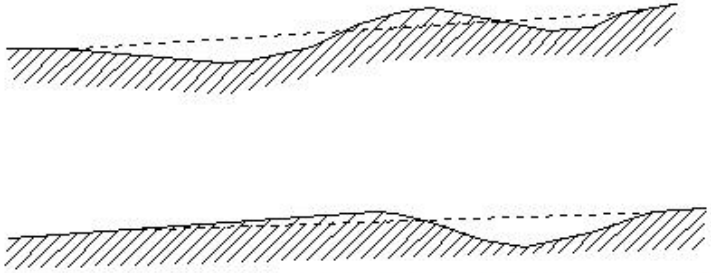
Waterway (Receiving waterway) (Diversion ditch)

- A waterway that directs water from higher ground to lower areas.
- It is used for various purposes, such as irrigating rice paddies and fields, or draining water into rivers and lakes.

Waterway (Receiving waterway) (Diversion ditch) (Intake channel) Intake channel

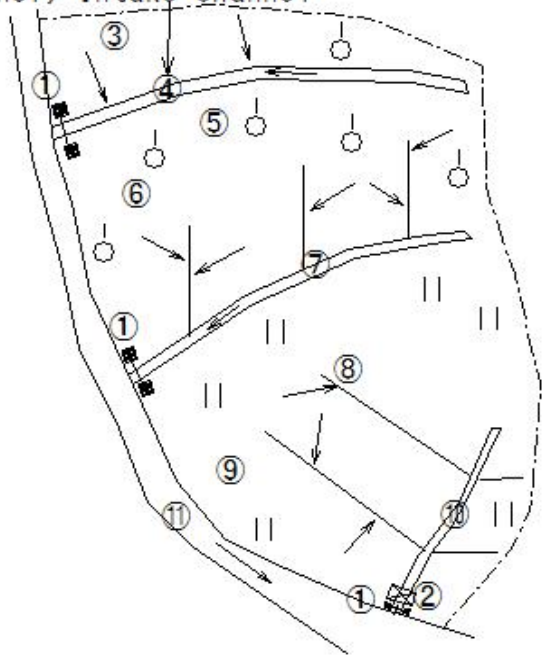


I18



④Wide-area channel-type terrace channel

I201



Layout of drainage facilities

(I905) Drainage facilities

(I905) Drainage facilities

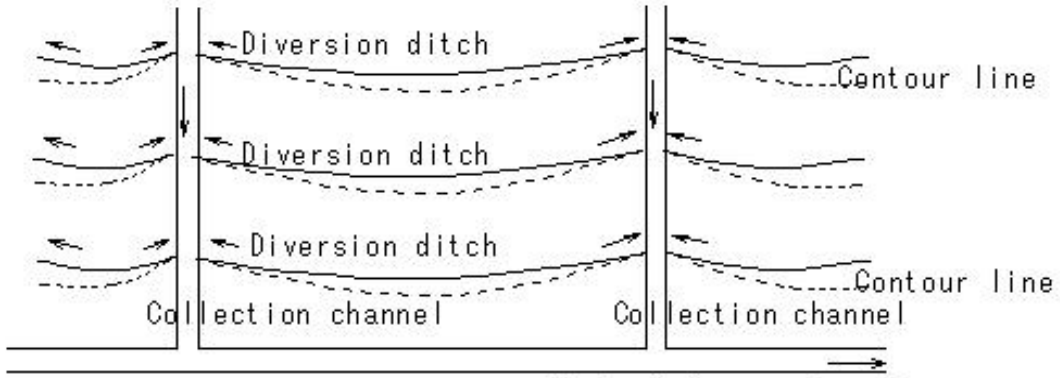
Waterway (Receiving waterway) (Diversion ditch)

・Types of catchment channels:

Catchment channels include open channels (channels installed above ground) and covered channels (channels buried underground).

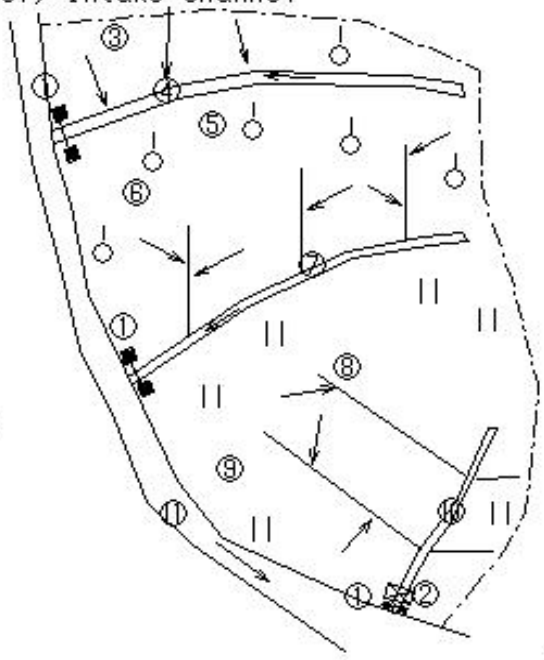
Waterway (Receiving waterway) (Diversion ditch) (Intake channel) Intake channel

Used for agricultural water and drainage purposes



I118

Layout of Diversion ditch



I903

Layout of drainage facilities

(I906) Drainage facilities

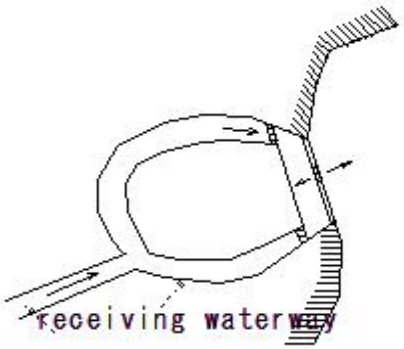
(I906) Drainage facilities

Waterway (Receiving waterway) (Diversion ditch)

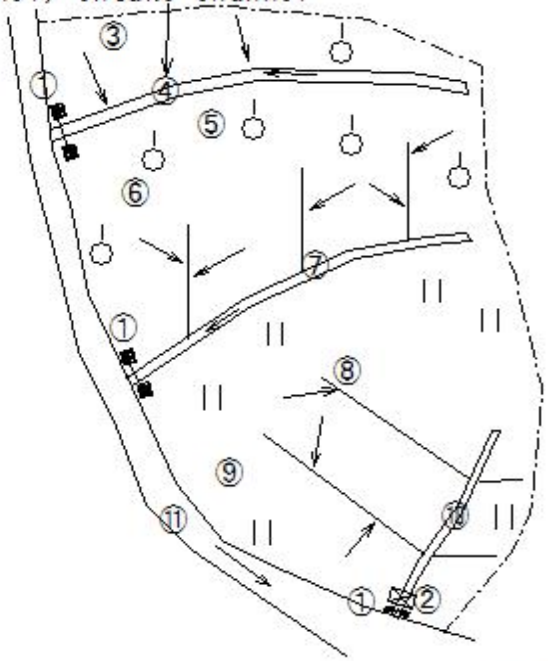
・Use of catchment channels:

To drain inland water during reclamation work and as a temporary channel during embankment construction work.

Waterway (Receiving waterway) (Diversion ditch) (Intake channel) Intake channel



I86
R543



Layout of drainage facilities

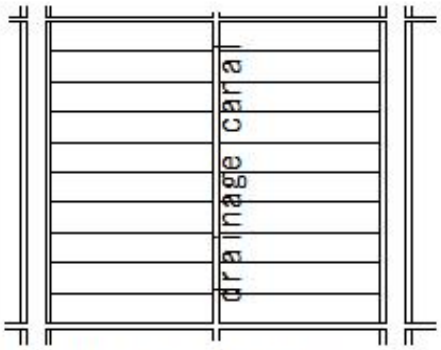
(I907) Drainage facilities

(I907) Drainage facilities

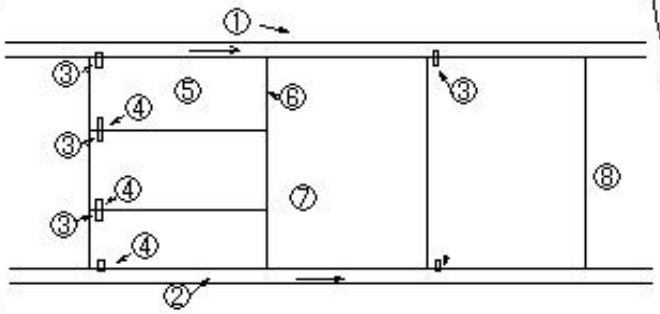
Drainage channels

Receiving channel → Drainage channel → Pump station → Drainage gate

Channels that collect surface water and groundwater and lead them to the drainage outlet at the downstream end of the district, main drainage channels, branch drainage channels, and small drainage channels

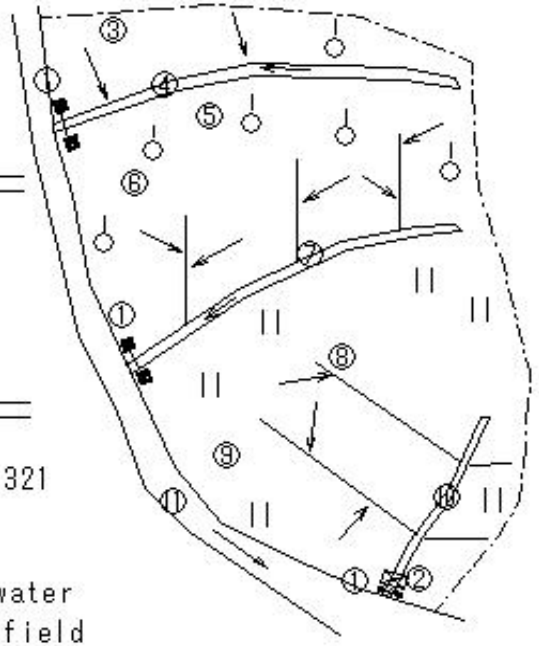


Paddy field plot I62 E463



Paddy sluice-Paddy field Drainage I321

① Water channel
② Drainage channel
③ Water inlet Intake of irrigation water
④ Water outlet Drainage from paddy field



I903

Layout of drainage facilities

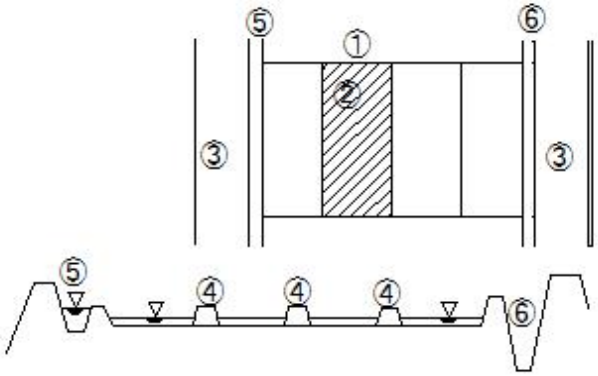
(I908) Drainage facilities

(I908) Drainage facilities

Drainage channels

Receiving channel → Drainage channel → Pump station → Drainage gate

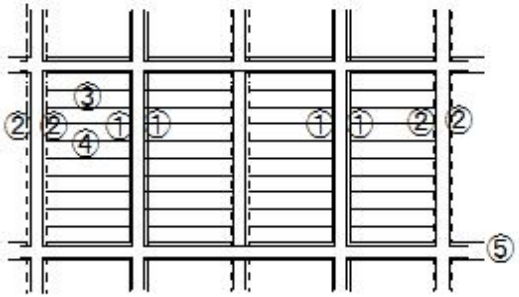
Channels that collect surface water and groundwater and lead them to the drainage outlet at the downstream end of the district, main drainage channels, branch drainage channels, and small drainage channels



Border lot(Ridge area)

① Cultivated area
② Ridge area
③ Cultivated road
④ Temporary ridge
⑤ Irrigation channel
⑥ Drainage channel

I353



Field division(Cultivated area)

① Small irrigation canal
② Small drainage canal
③ Field division(Cultivated area)
④ Ridge
⑤ Cultivated road

I457

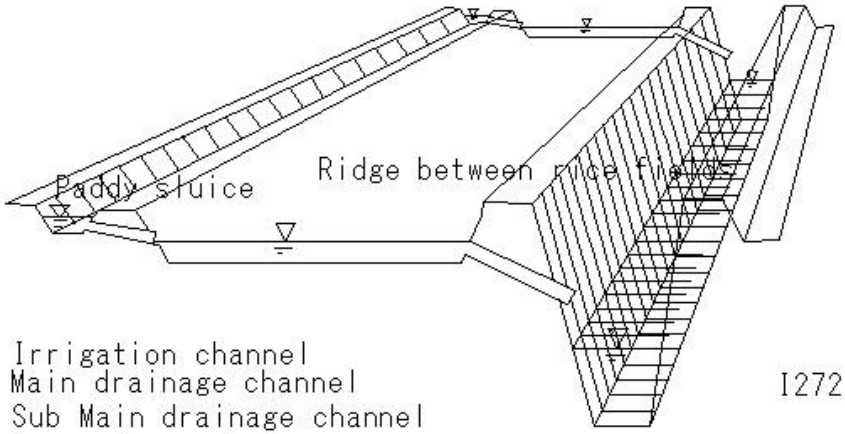
(I909) Drainage facilities

(I909) Drainage facilities

Drainage channels

Receiving channel → Drainage channel → Pump station → Drainage gate

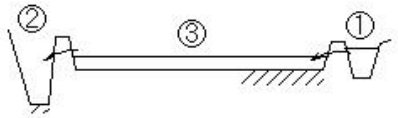
Channels that collect surface water and groundwater and lead them to the drainage outlet at the downstream end of the district, main drainage channels, branch drainage channels, and small drainage channels



Irrigation channel
Main drainage channel
Sub Main drainage channel
Lateral canal

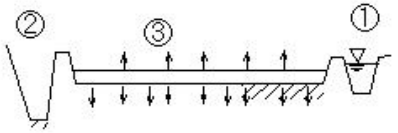
I272

Drainage channel



Continuous irrigation
① Irrigation channel
② Drainage channel
③ paddy field

I35



Flushing irrigation
① Irrigation channel
② Drainage channel
③Paddy field

I36

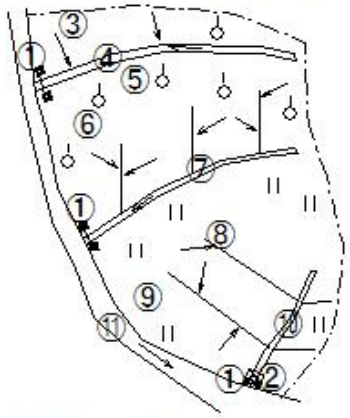
(I910) Drainage facilities

(I910) Drainage facilities

Drainage sluice gates and drainage gates

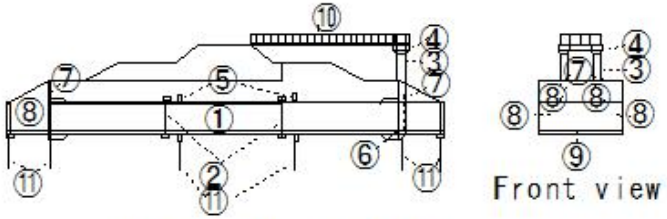
Intake channel → Drainage channel → Pump station → Drainage sluice gates

In case of rainwater or rice paddy water from within a levee flows through a river or waterway and joins a larger river, this facility is set up to prevent the water from



①Drainage sluice gate
②Drainage pumping station
③Forest behind
④Waterway (Receiving waterway)
Diversion ditch) (Intake channel) Intake channel
⑤High-level farmland
⑥Natural drainage basin
⑦High-level drainage channel
⑧Bottom-level farmland
⑨Mechanical drainage basin
⑩Bottom-level drainage channel
⑪Drainage river

I903



Front view

Sluice, sluice pipe

①Box ditch
②Joint
③Gatepost
④Gate operation table
⑤Impermeable wall
⑥Gate
⑦Battlements
⑧Wing wall
⑨Water tapping
⑩Management bridge
⑪Waterproof work

R270

(I911) Drainage facilities

(I911) Drainage facilities

Flood bypass(Spillage channels)

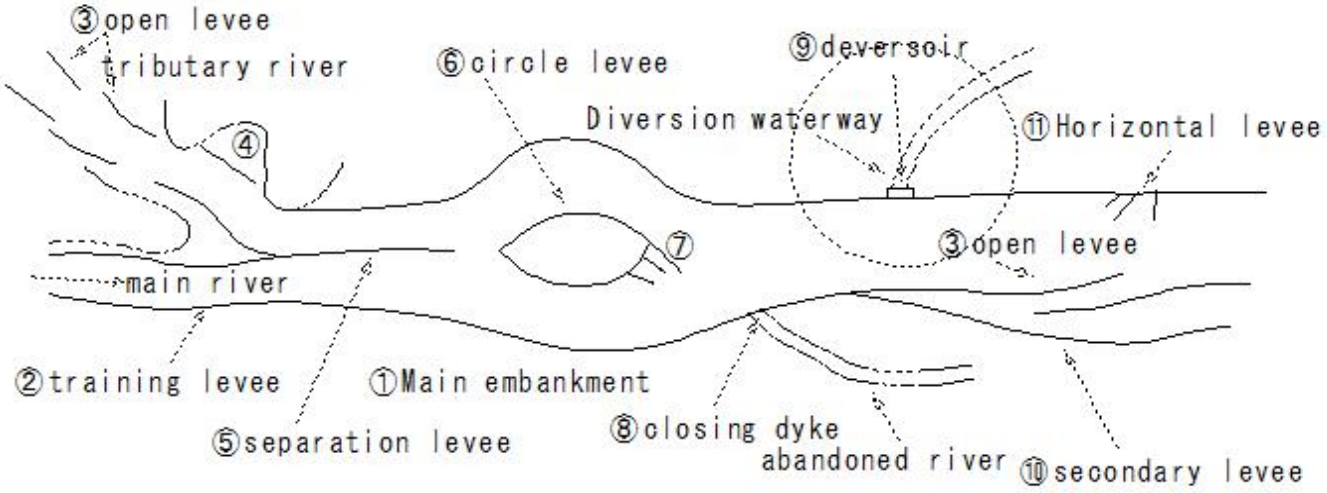
Spillage channels are artificial waterways that divert part of a river and release it to another location to prevent flooding.

The role of spillways:

① Flood reduction:

② Measures to prevent river mouth blockages:

③ Measures to prevent flooding in cities:



I413
R323

(I912) Drainage facilities

(I912) Drainage facilities

Flood bypass(Spillage channels)

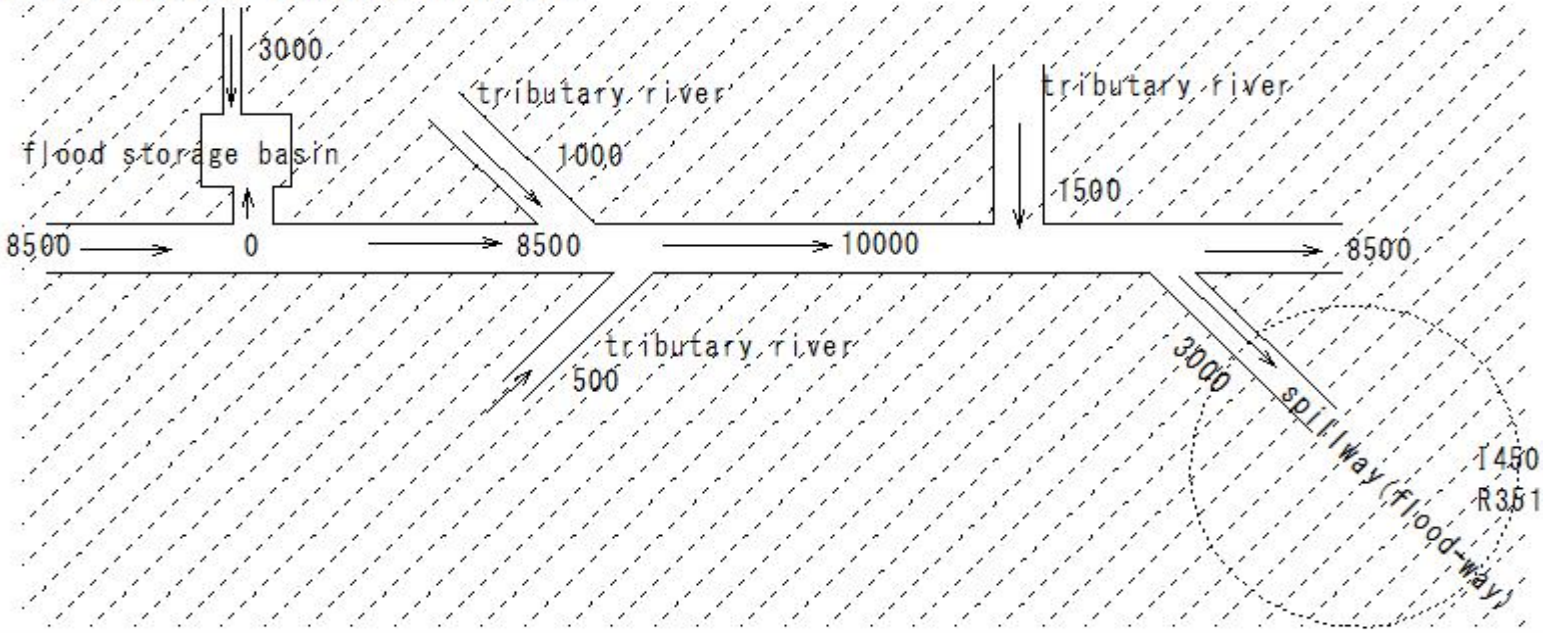
Spillage channels are artificial waterways that divert part of a river and release it to another location to prevent flooding.

The role of spillways:

① Flood reduction:

② Measures to prevent river mouth blockages:

③ Measures to prevent flooding in cities:



(I913) Drainage facilities

(I913) Drainage facilities

Flood bypass(Spillage channels)

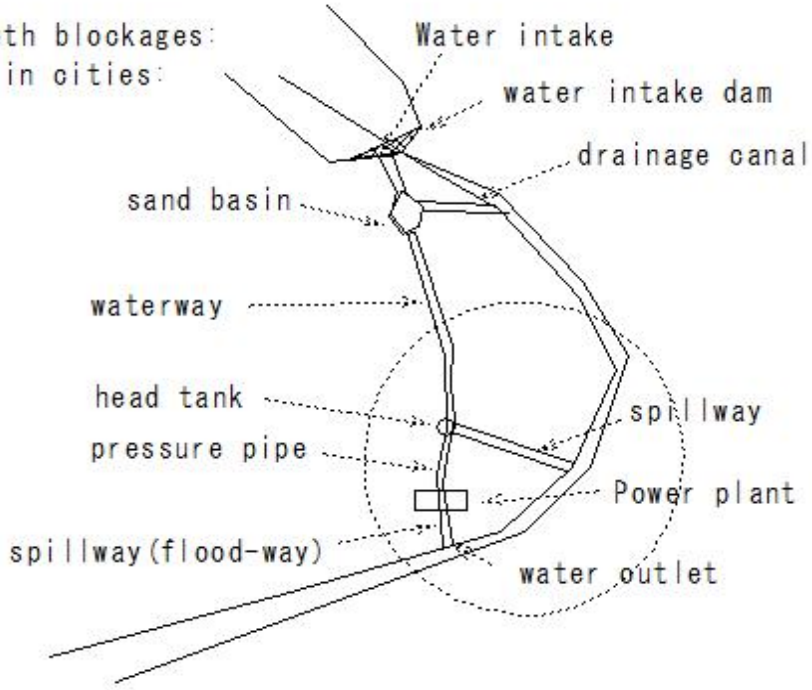
Spillage channels are artificial waterways that divert part of a river and release it to another location to prevent flooding.

The role of spillways:

① Flood reduction:

② Measures to prevent river mouth blockages:

③ Measures to prevent flooding in cities:



I547
D220
R392

(I914) Drainage facilities

(I914) Drainage facilities

Flood bypass(Spillage channels)

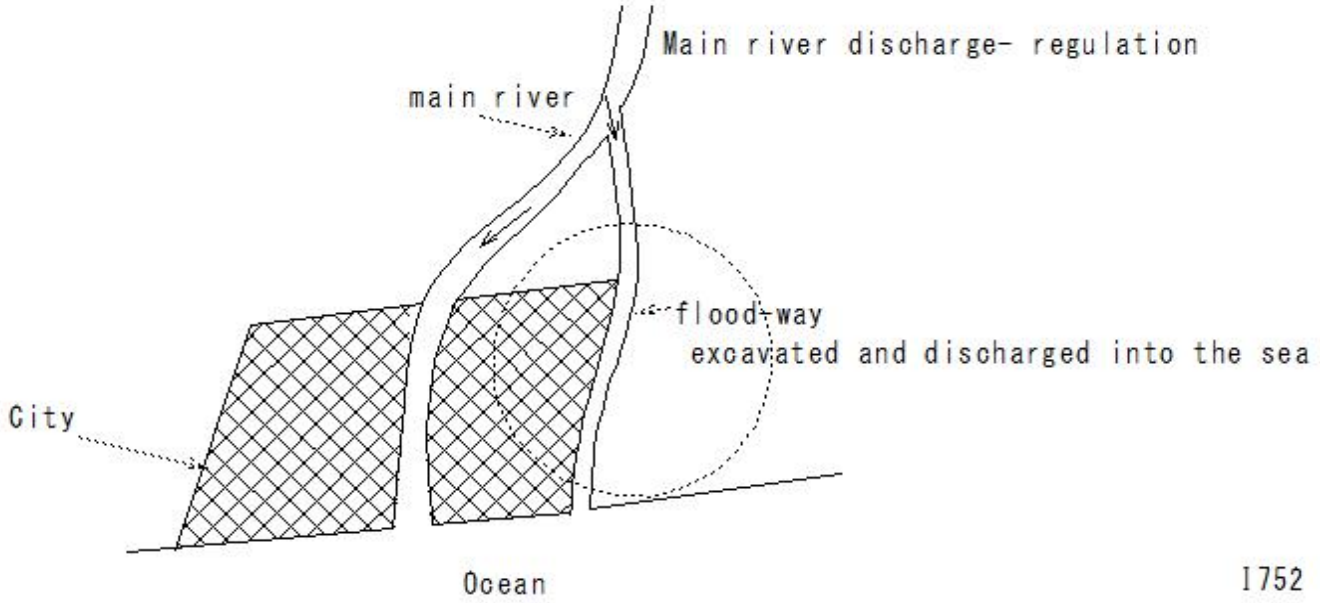
Spillage channels are artificial waterways that divert part of a river and release it to another location to prevent flooding.

The role of spillways:

① Flood reduction:

② Measures to prevent river mouth blockages:

③ Measures to prevent flooding in cities:



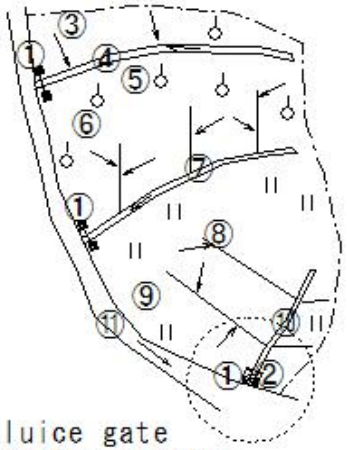
I752

(I915) Mechanical drainage

(I915) Mechanical drainage

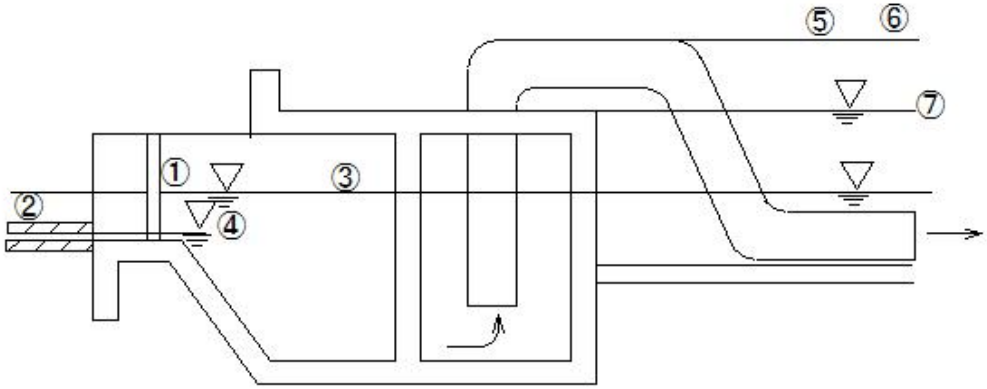
Mechanical drainage

Mechanical drainage is a method of forcibly draining water using pumps or other machines when the natural slope alone is not sufficient for drainage.



①Drainage sluice gate
②Drainage pumping station
③Forest behind
④Waterway (Receiving waterway)

⑤High-level farmland
⑥Natural drainage basin
⑦High-level drainage channel
⑧Bottom-level farmland
⑨Mechanical drainage basin
⑩Bottom-level drainage channel
⑪Drainage river



Cross section of pump station

① Inner water level
② Lowest rice field level
③ High water level
④ Low water level
⑤ Outer water level
⑥ Highest water level
⑦ High water level

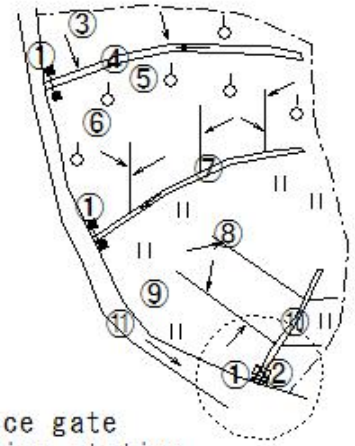
I903

(I916) Mechanical drainage

Mechanical drainage

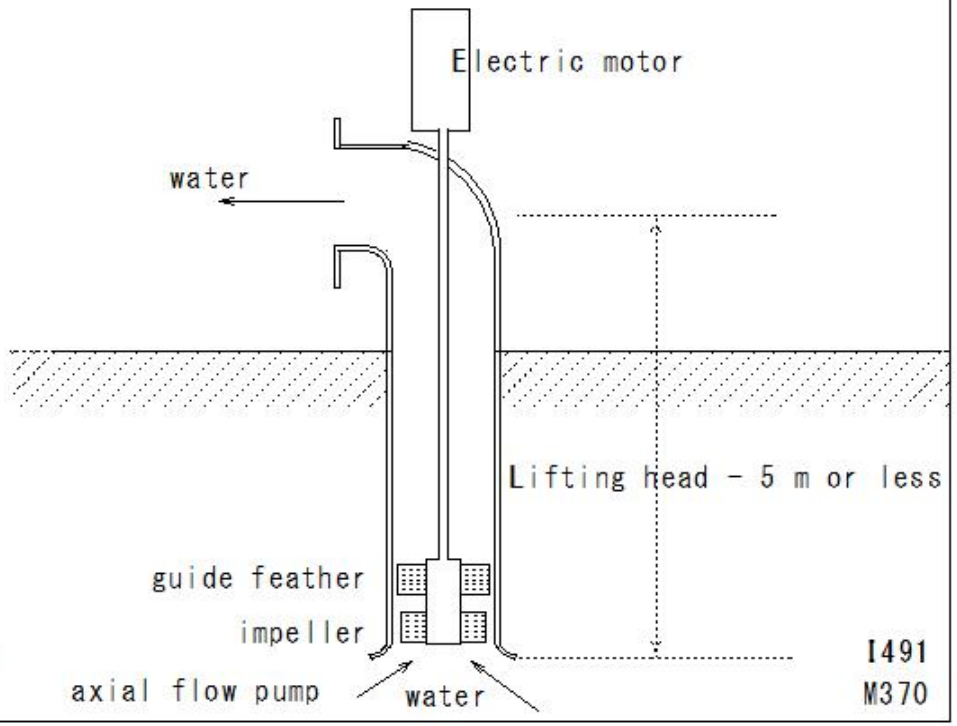
Axial flow pump

Mechanical drainage is a method of forcibly draining water using pumps or other machines when the natural slope alone is not sufficient for drainage.



①Drainage sluice gate
②Drainage pumping station
③Forest behind
④Waterway (Receiving waterway)
⑤High-level farmland
⑥Natural drainage basin
⑦High-level drainage channel
⑧Bottom-level farmland
⑨Mechanical drainage basin
⑩Bottom-level drainage channel
⑪Drainage river

I903



I491
M370

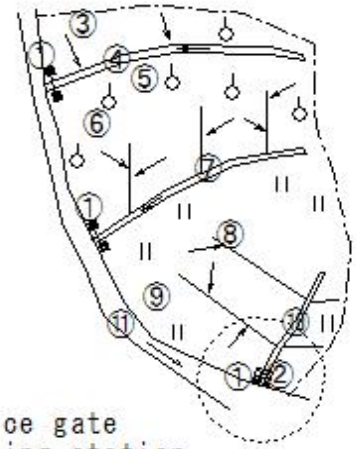
(I917) Mechanical drainage

(I917) Mechanical drainage

Mechanical drainage

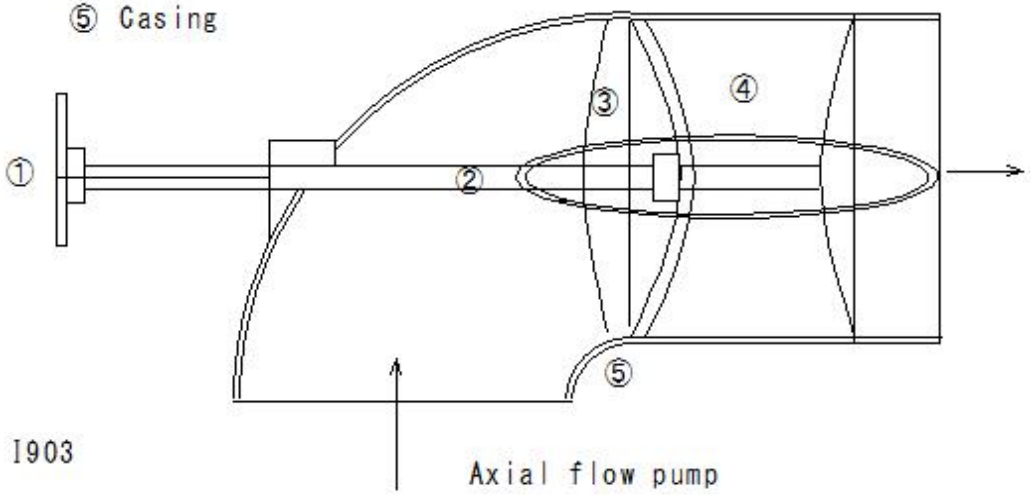
Axial flow pump

Mechanical drainage is a method of forcibly draining water using pumps or other machines when the natural slope alone is not sufficient for drainage.



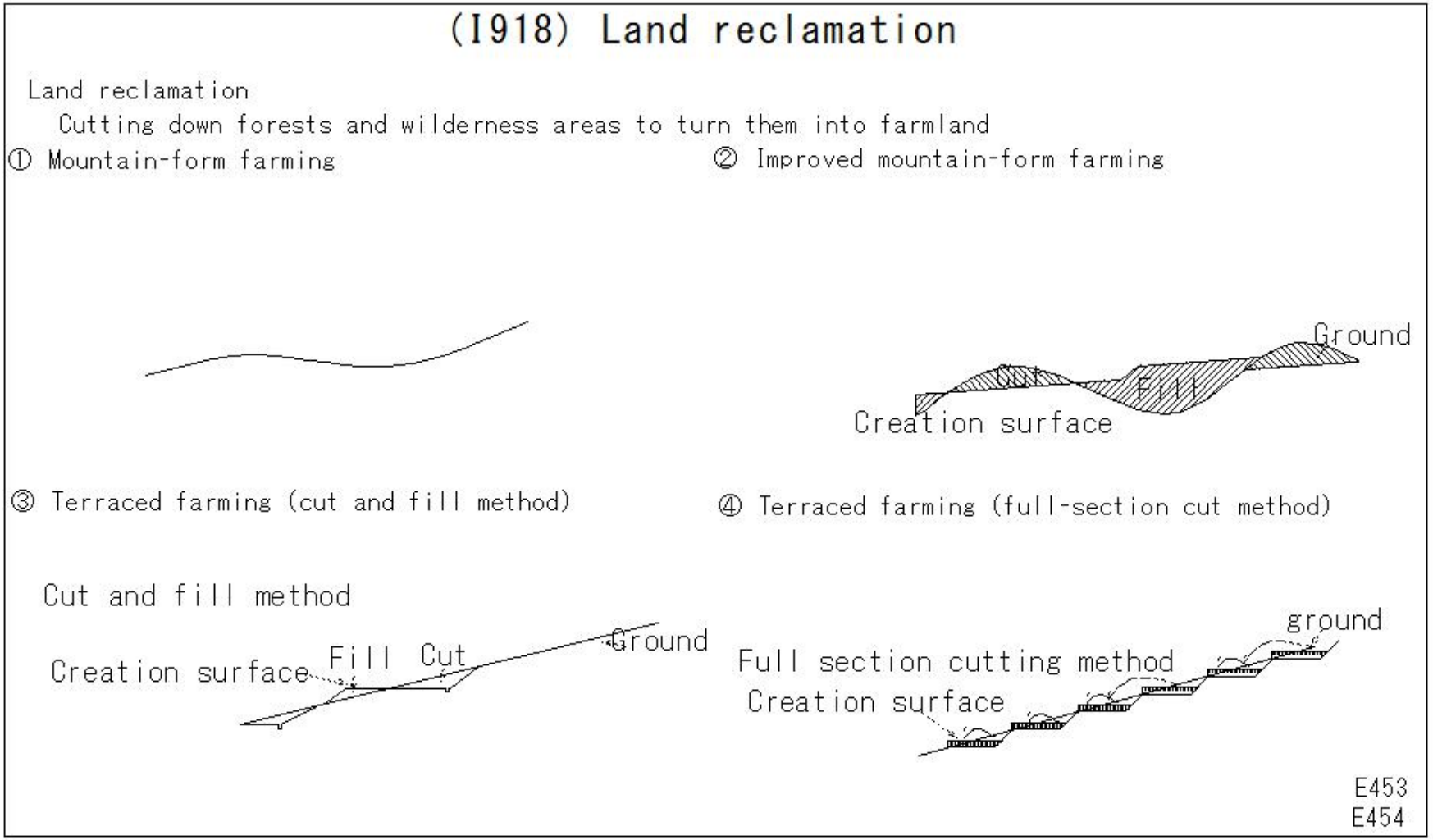
①Drainage sluice gate
②Drainage pumping station
③Forest behind
④Waterway (Receiving waterway)
⑤High-level farmland
⑥Natural drainage basin
⑦High-level drainage channel
⑧Bottom-level farmland
⑨Mechanical drainage basin
⑩Bottom-level drainage channel
⑪Drainage river

① Power source
② Main shaft
③ Impeller
④ Guide vane
⑤ Casing



I903

(I918) Land reclamation



(I919) Land reclamation

(I919) Land reclamation

Land reclamation

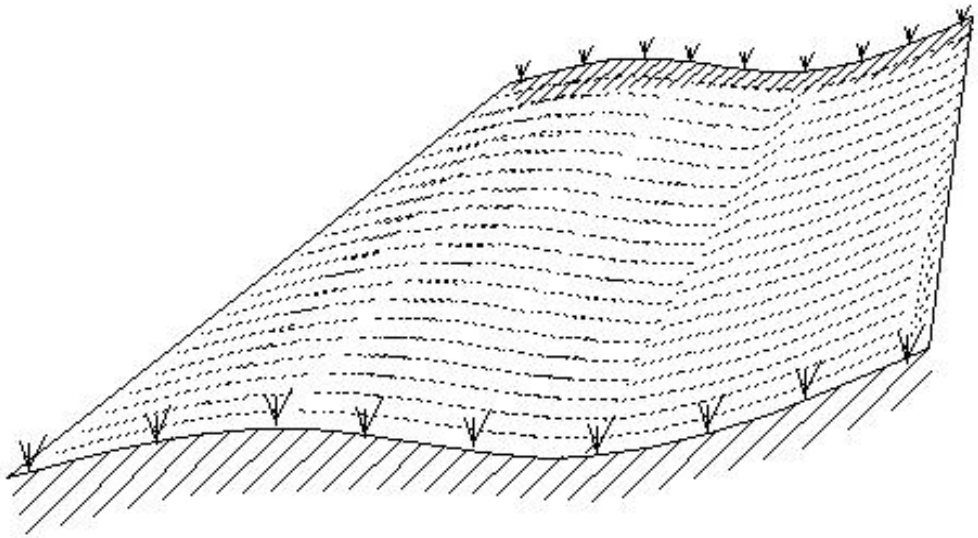
Cutting down forests and wilderness areas to turn them into farmland

① Mountain-form farming

This method utilizes the local topography as it is, using the slopes of mountains and hills as fields.

① Generally applies to relatively gentle slopes of 15 degrees or less.

② In pastures, it can be applied to slopes of up to 30 degrees,
but in that case partial plowing (plowing the field) is performed for conservation purposes.



E453
E454

(I920) Land reclamation

(I920) Land reclamation

Land reclamation

Cutting down forests and wilderness areas to turn them into farmland

① Mountain-form farming

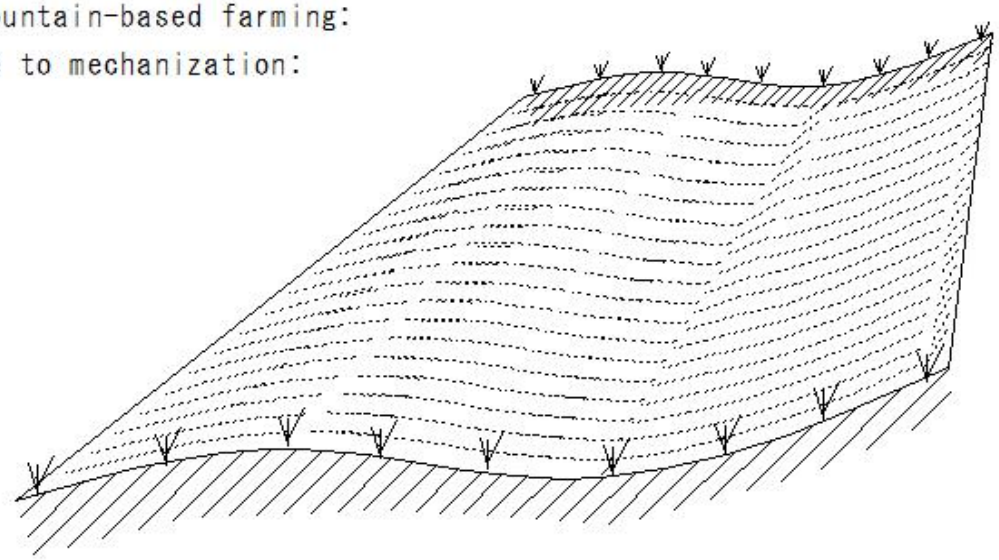
This method utilizes the local topography as it is, using the slopes of mountains and hills as fields.

The advantages of Mountain-based farming

1. Improved work efficiency through mechanization:
2. Soil conservation:
3. Harmony with the landscape:

The disadvantages of Mountain-based farming:

4. Work limitations due to mechanization:
5. Difficulty of work:



E453
E454

(I921) Land reclamation

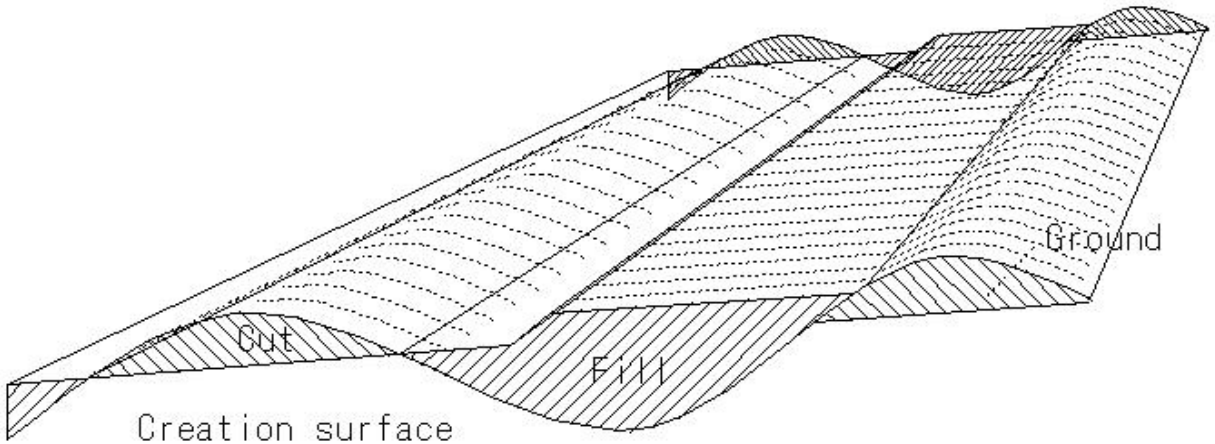
(I921) Land reclamation

① A method of shaping the current complex terrain slopes by cutting and filling, and creating farmland with a gentle slope overall.

② A construction method in which mountains are cut away from the current terrain, valleys are filled in, and farmland with a gentle slope is created. The effective farm

③ A method of creating farmland that reduces the slope of the terrain and increases the size of the farmland by destroying mountains and filling in valleys.

Improved mountain-form farming



E453
E454

(I922) Land reclamation

(I922) Land reclamation

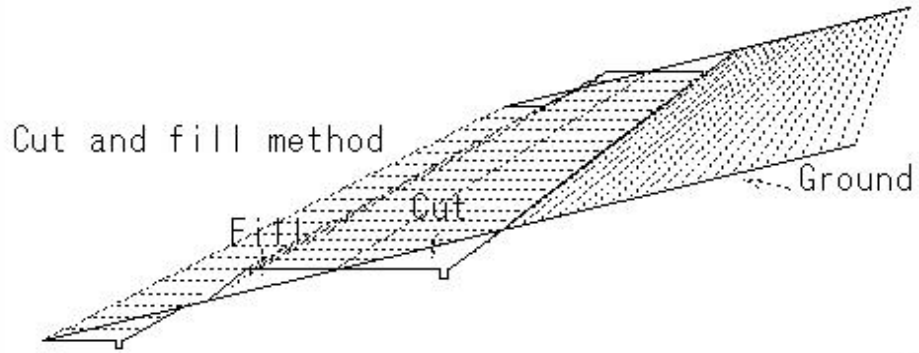
③ Terraced farming (cut and fill method)

④ Terraced farming (full-section cut method)

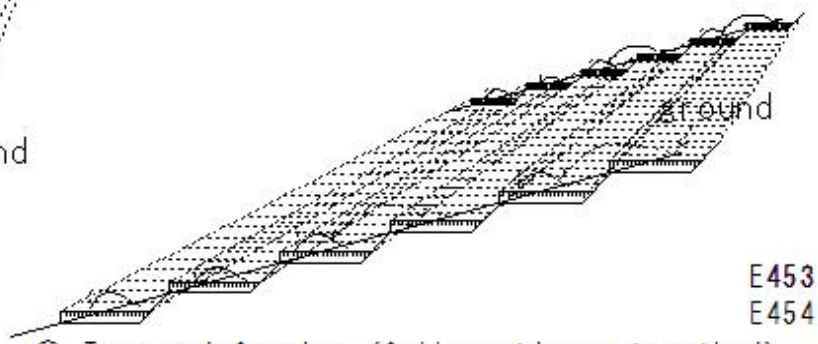
① This is a method of finishing steeply sloping land in a stepped shape by cutting and filling. The amount of earthwork is relatively small, but the rate of crushed land due to the step slope is high.

② The degree of freedom of the work footing is small, and the footing for the construction machinery is also unstable, so original vegetation, etc. is dealt with at the same time as cutting and filling as much as possible.

③ This is a method of finishing steeply sloping land in a stepped shape by cutting and filling. The amount of earthwork is relatively small, but the rate of crushed land due to the step slope is high.



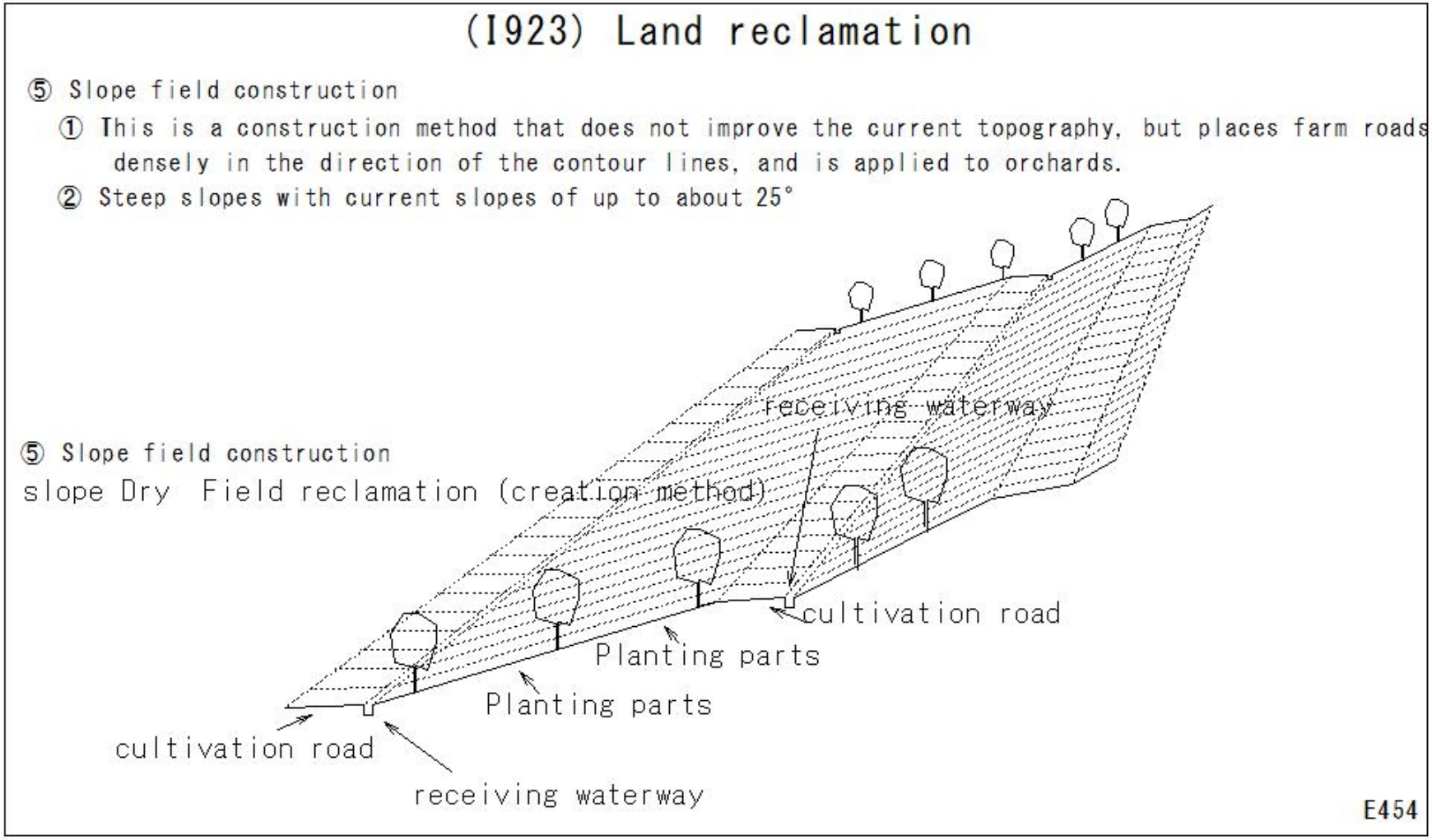
③ Terraced farming (cut and fill method)



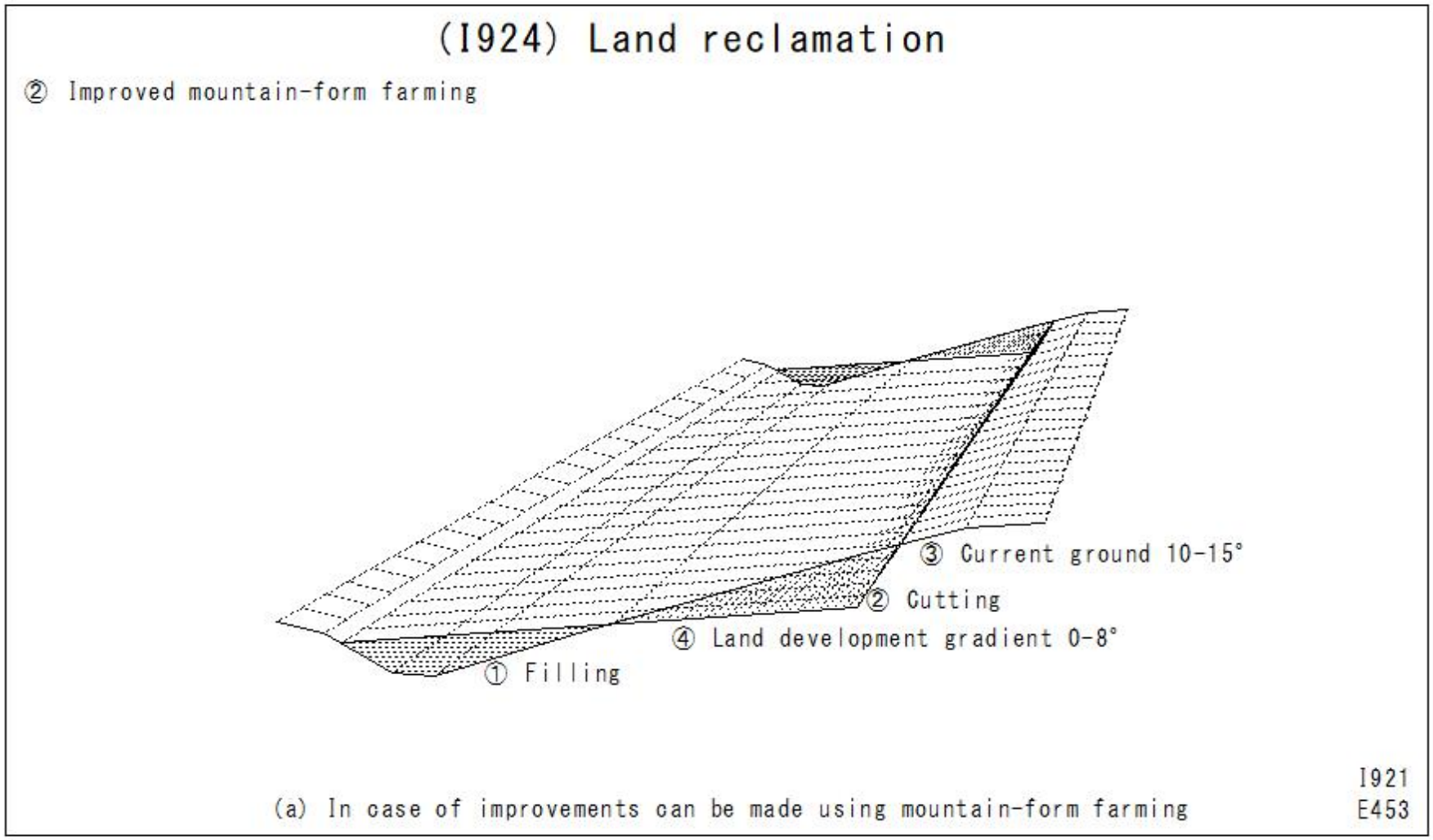
E453
E454

④ Terraced farming (full-section cut method)

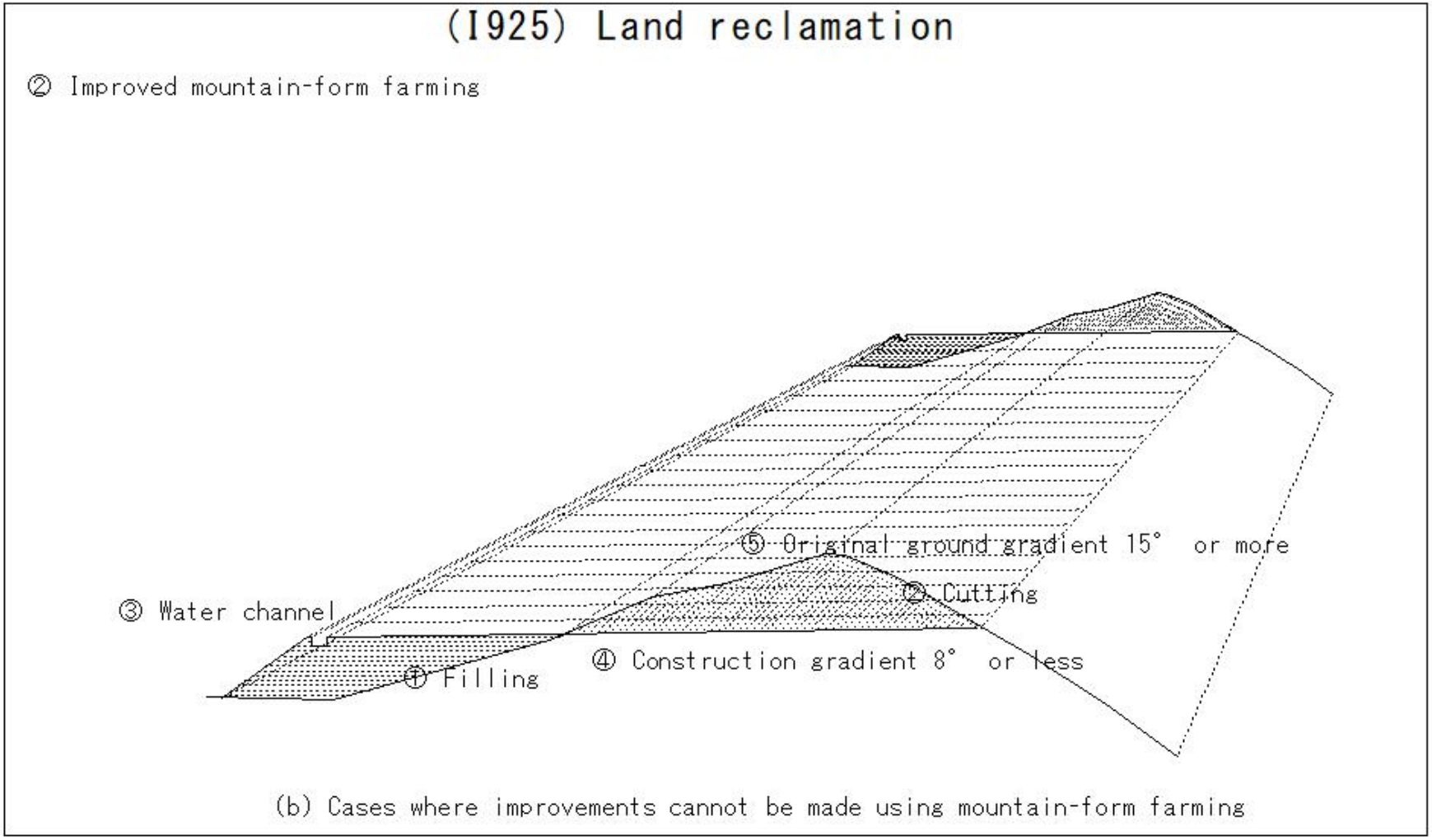
(I923) Land reclamation



(I924) Land reclamation



(I925) Land reclamation



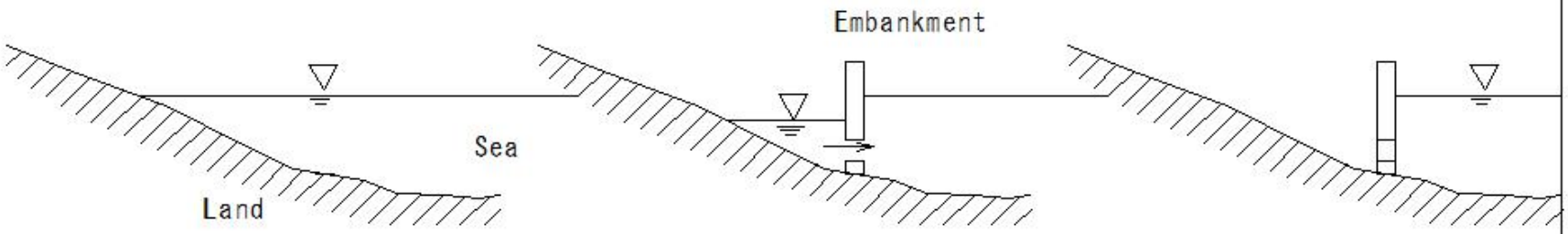
(I926) Reclamation and Landfill（land reclamation）

(I926) Reclamation and Landfill (land reclamation)

Reclamation

① Draining lakes, marshes, lagoons, etc. to turn them into land or farmland
② Draining the water from the sea or lake by dividing it with a dike to increase the land area
③ Construction work to turn the sea or lake into land
④ It is characterized by draining the water from that area to turn it into land.

Reclamation



(I927) Reclamation and Landfill（land reclamation）

(I927) Reclamation and Landfill (land reclamation)

Reclamation

Purpose:To prevent damage caused by tides in the sea or lake.

To use as farmland　To promote economic development in the local community.

reclamation in water area

Embankments, drainage gates, drainage pump stations, sluice gate

Ocean

lakes and marshes

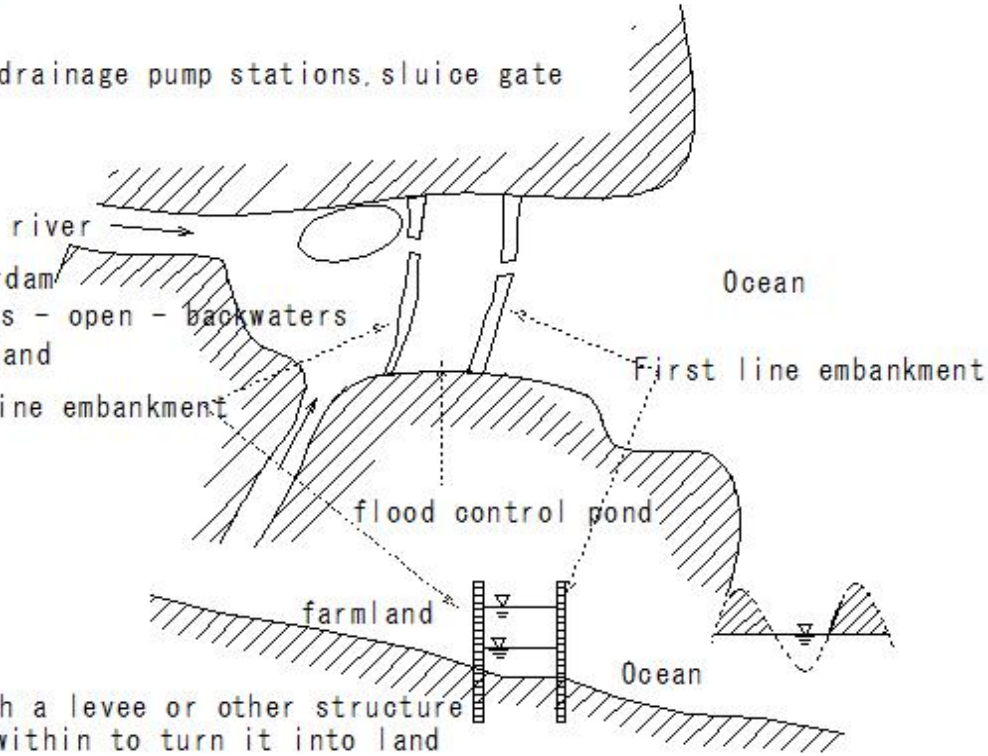
Drain the inside water

Bottom - Farmland

・Low wetland-levee-cofferdam

・During low tide, tide gates - open - backwaters

・Pump drainage - obtain land



To enclose a body of water with a levee or other structure and remove the water from within to turn it into land

I40

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(I928) Reclamation and Landfill（land reclamation）

(I928) Reclamation and Landfill (land reclamation)

Reclamation

Method:

Build a dike to separate the sea or lake.

Install floodgates in the dike and drain the water using the tides, or force it out with a pump.

Install floodgates in the dike and drain the water using the tides, or force it out with a pump.

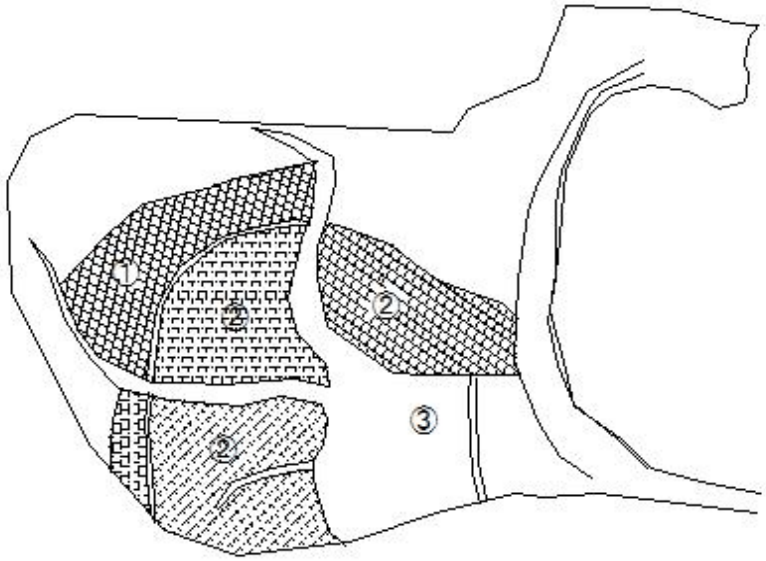
Use the drained area for farming or other purposes.

Land reclamation (compound land reclamation)

①②③ Construction sequence

Freshwater lake

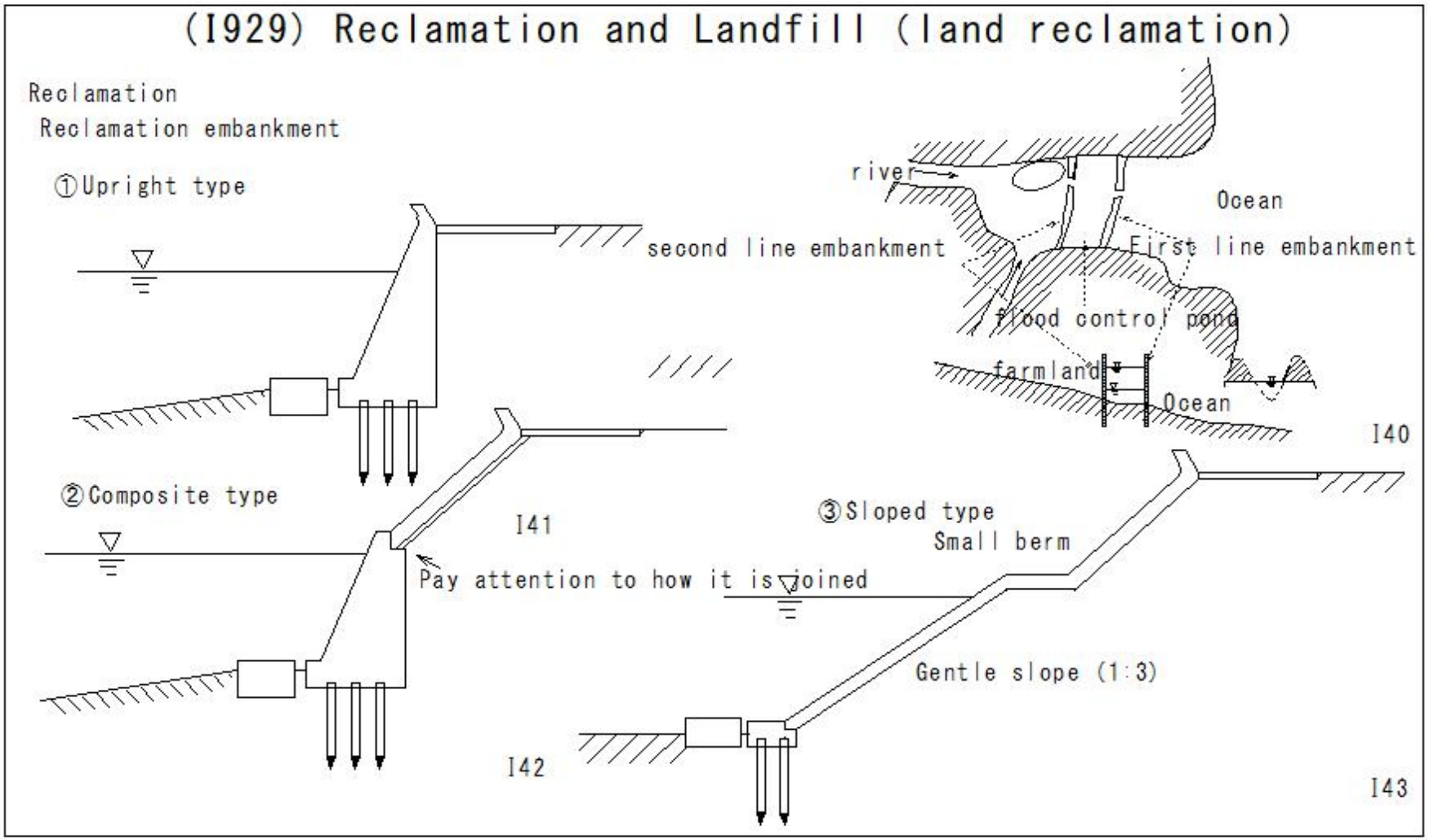
A waterway that collects and removes inflowing water



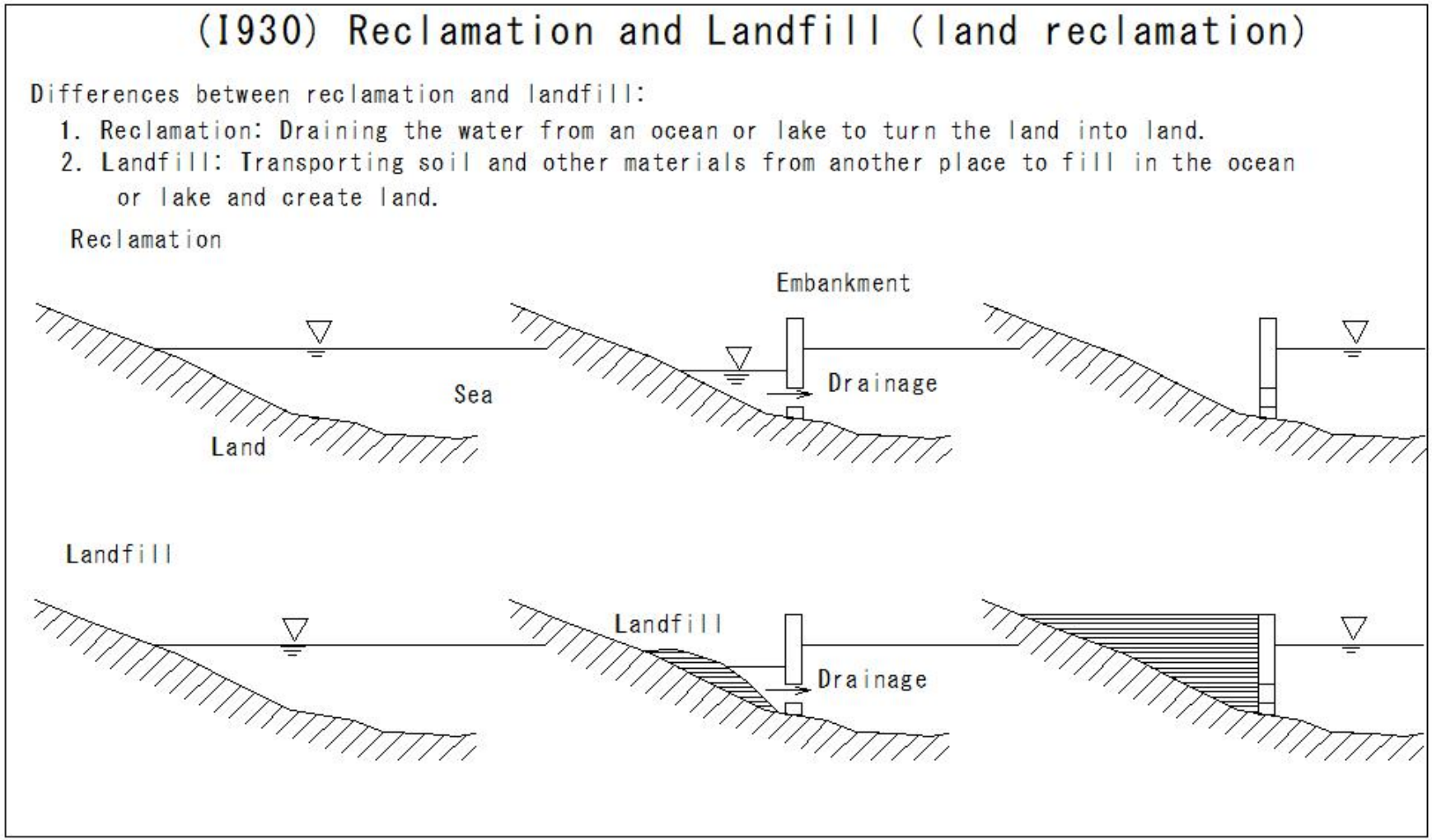
Land reclamation (compound land reclamation)

I260

(I929) Reclamation and Landfill（land reclamation）



(I930) Reclamation and Landfill (land reclamation)



(I931) Reclamation and Landfill（land reclamation）

(I931) Reclamation and Landfill (land reclamation)

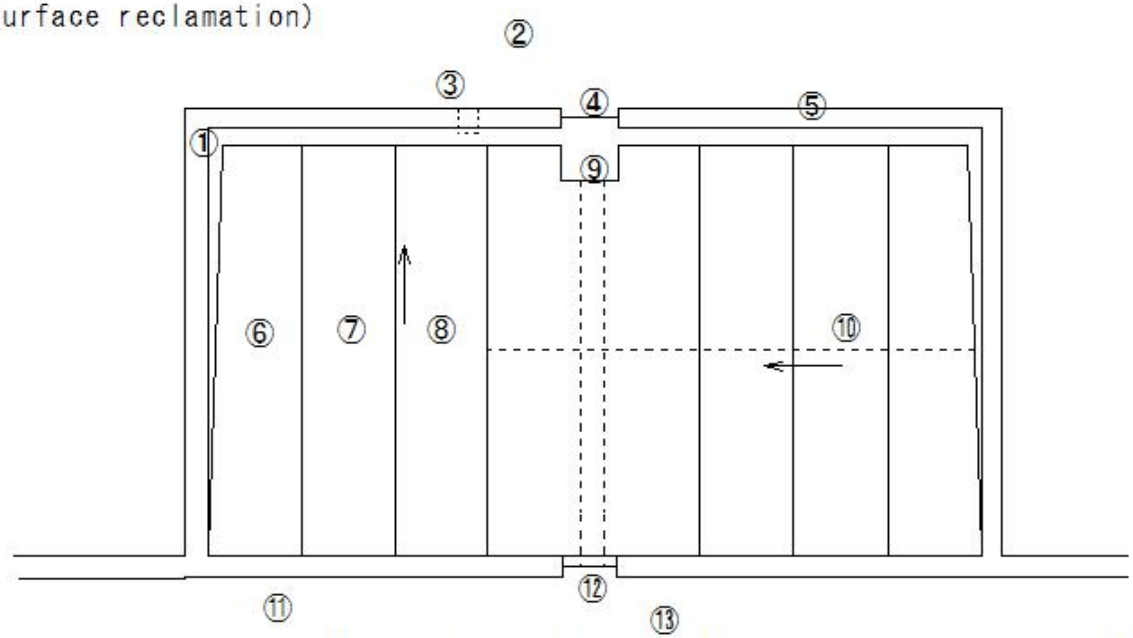
Reclamation by single dike

① A reclamation method that uses a single embankment to protect against the open tide.

② A dike is built around a shallow sea to prevent seawater from entering, and then the inside is dried up.

Sea bottom reclamation (Sea surface reclamation)

① Place with the tide
② Sea surface
③ Tide stop gate
④ Drain gate
⑤ Levee
⑥ Irrigation channel
⑦ Drainage channel
⑧ Irrigation channel
⑨ Reservoir
⑩ Drainage channel
⑪ Levee
⑫ Hindland drainage gate
⑬ Land



Reclamation by single dike

I401

(I932) Reclamation and Landfill（land reclamation）

(I932) Reclamation and Landfill (land reclamation)

Composite reclamation

1. A method in which the mouth of a bay is first closed off to create an inland water surface, and then a dike is built to surround it.
2. A composite reclamation method that uses a double dike to protect against open tides.

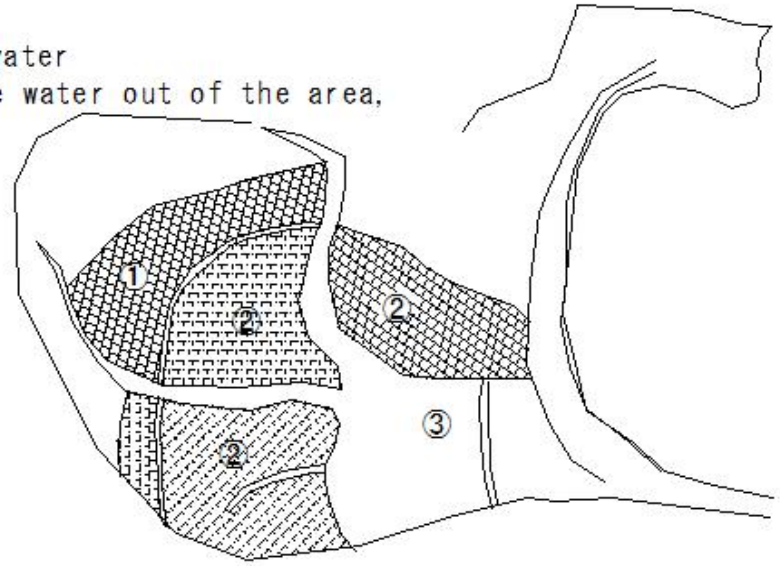
: The mouth of the bay is closed off, a dike is built, and the water in the area is removed to make it dry land.

Land reclamation (compound land reclamation)

①②③ Construction sequence

Freshwater lake

A waterway that collects and removes inflowing water from the river basin outside the bank to lead the water out of the area.



(I933) Reclamation and Landfill（land reclamation）

(I933) Reclamation and Landfill (land reclamation)

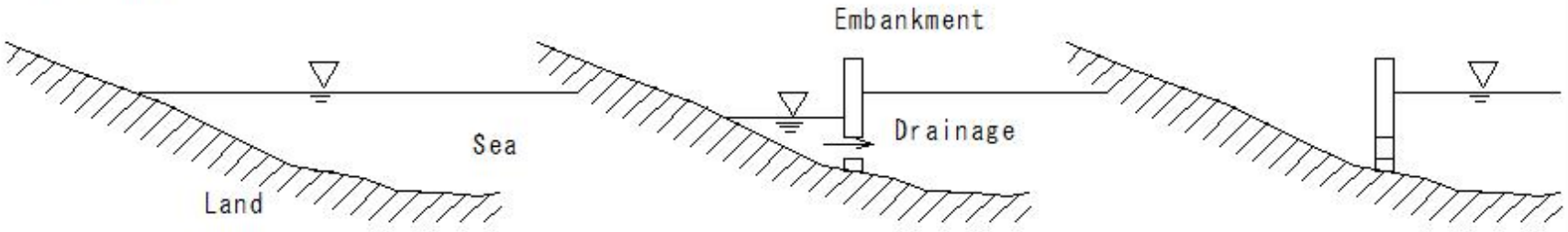
Reclamation

① Reclamation is the process of surrounding a body of water with a dike or other structure, draining the water through a sluice gate, and turning the area into land.

Method: Surround a body of water with a dike, drain the water, and turn the area into land.

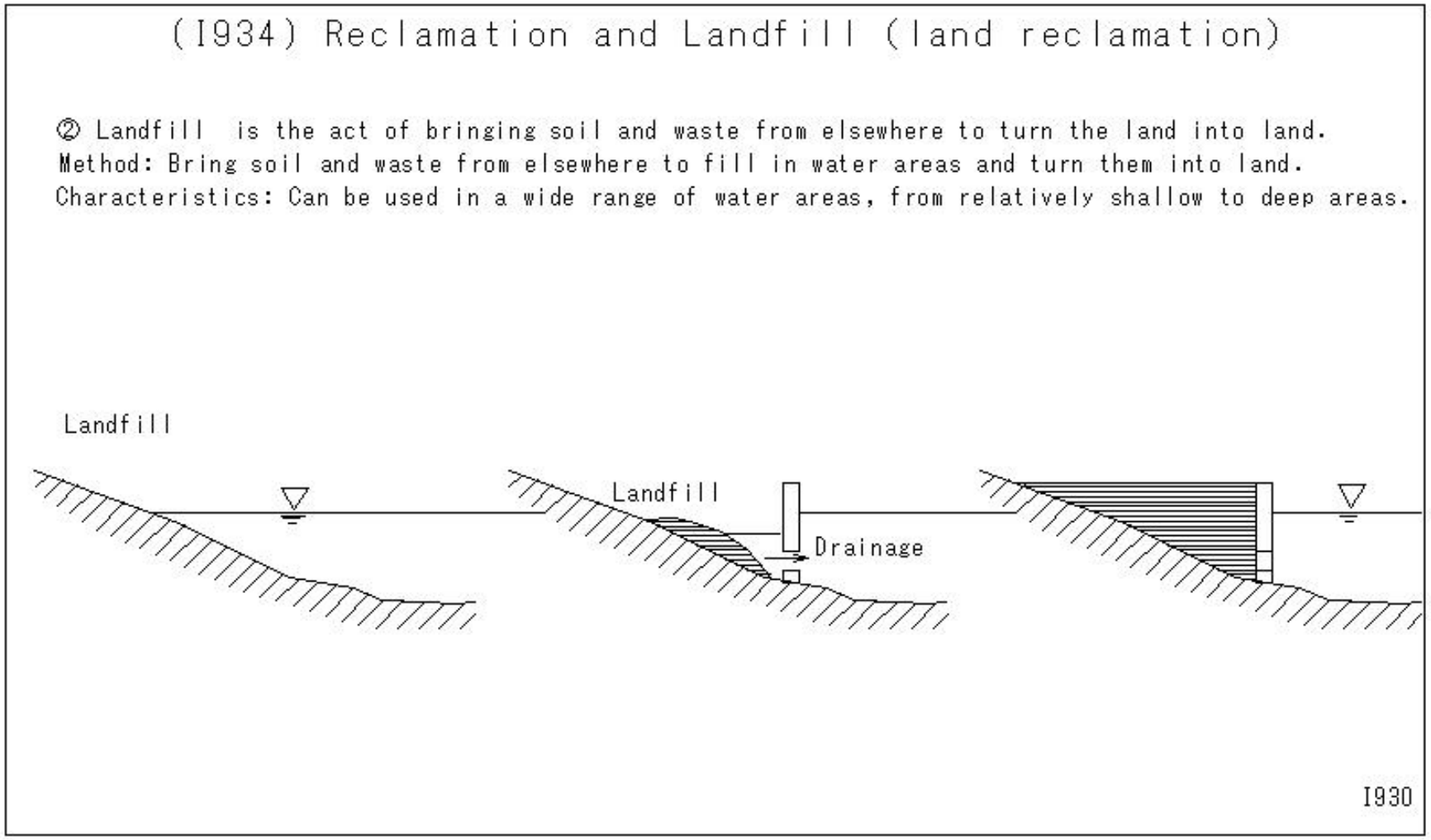
Characteristics: Often used in areas where water naturally accumulates, such as shallow seas and lakes.

Reclamation



I930

(I934) Reclamation and Landfill（land reclamation）



(I935) Field consolidation

(I935) Field consolidation

Field consolidation

① Land rezoning

② Construction of farm roads,

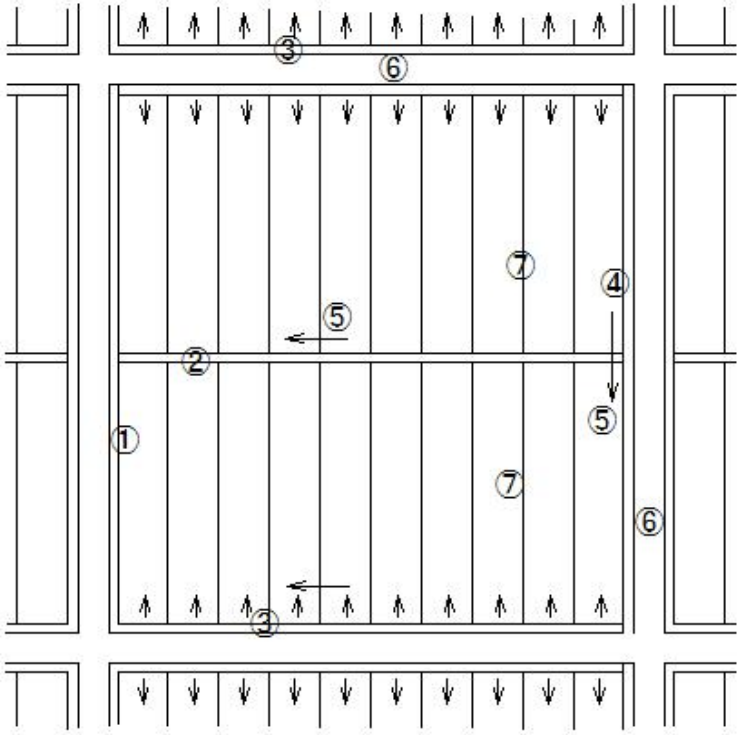
③ Construction of agricultural irrigation and drainage channels, etc.

④ Improve agricultural efficiency

⑤ Use of large machinery

⑥ Facilitate water management

⑦ Improve agricultural productivity



① Branch drainage channel

② Small drainage channel

③ Small irrigation channel

④ Branch irrigation channel

⑤ Water movement

⑥ Farm road

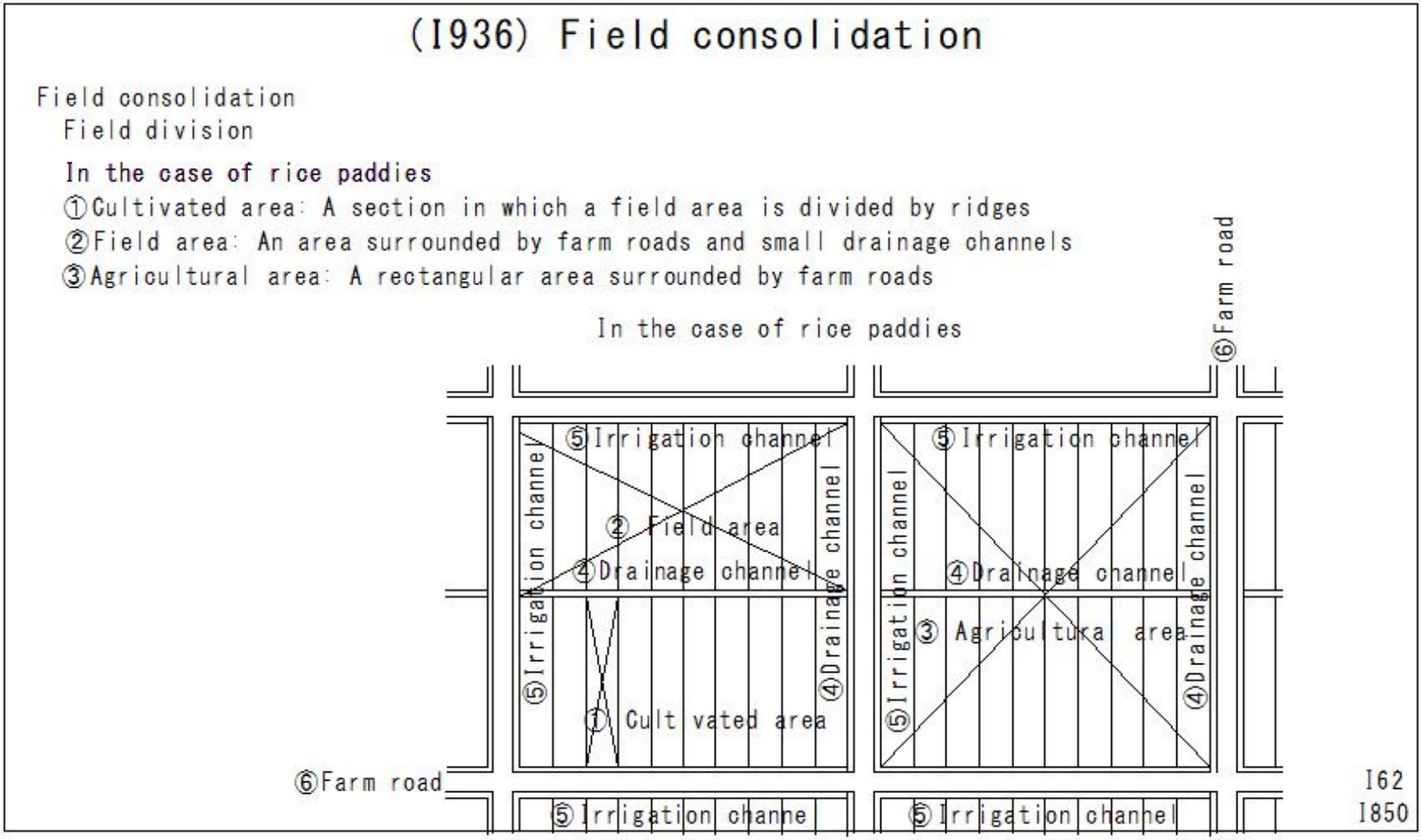
⑦ Rice ridge

Paddy field plot

I62

I850

(I936) Field consolidation



(I937) Field consolidation

(I937) Field consolidation

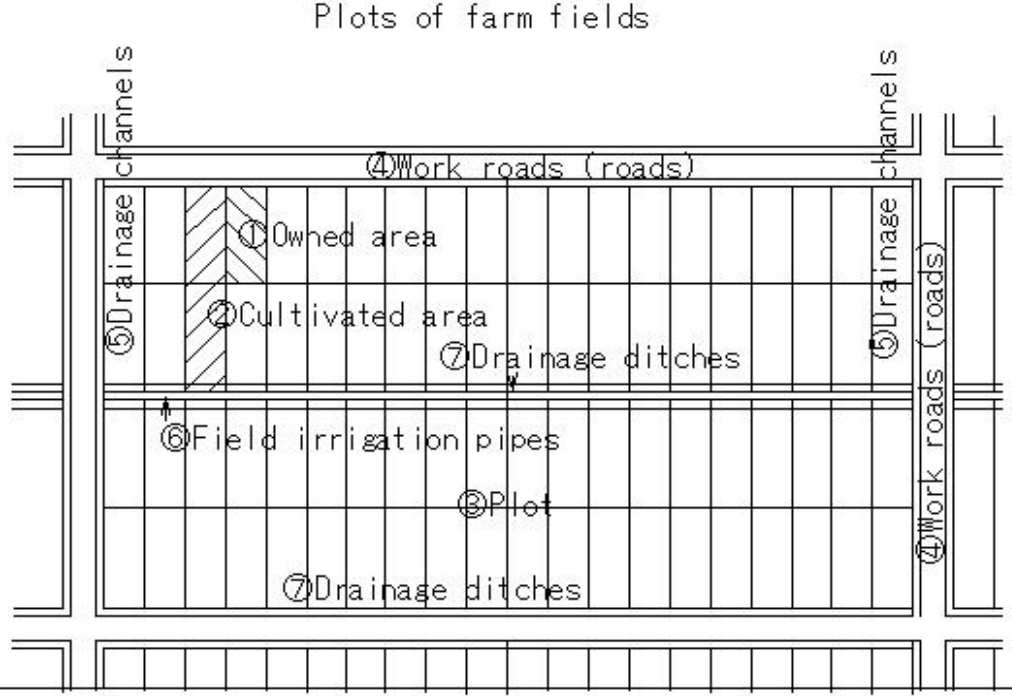
Field consolidation

Plots of farm fields

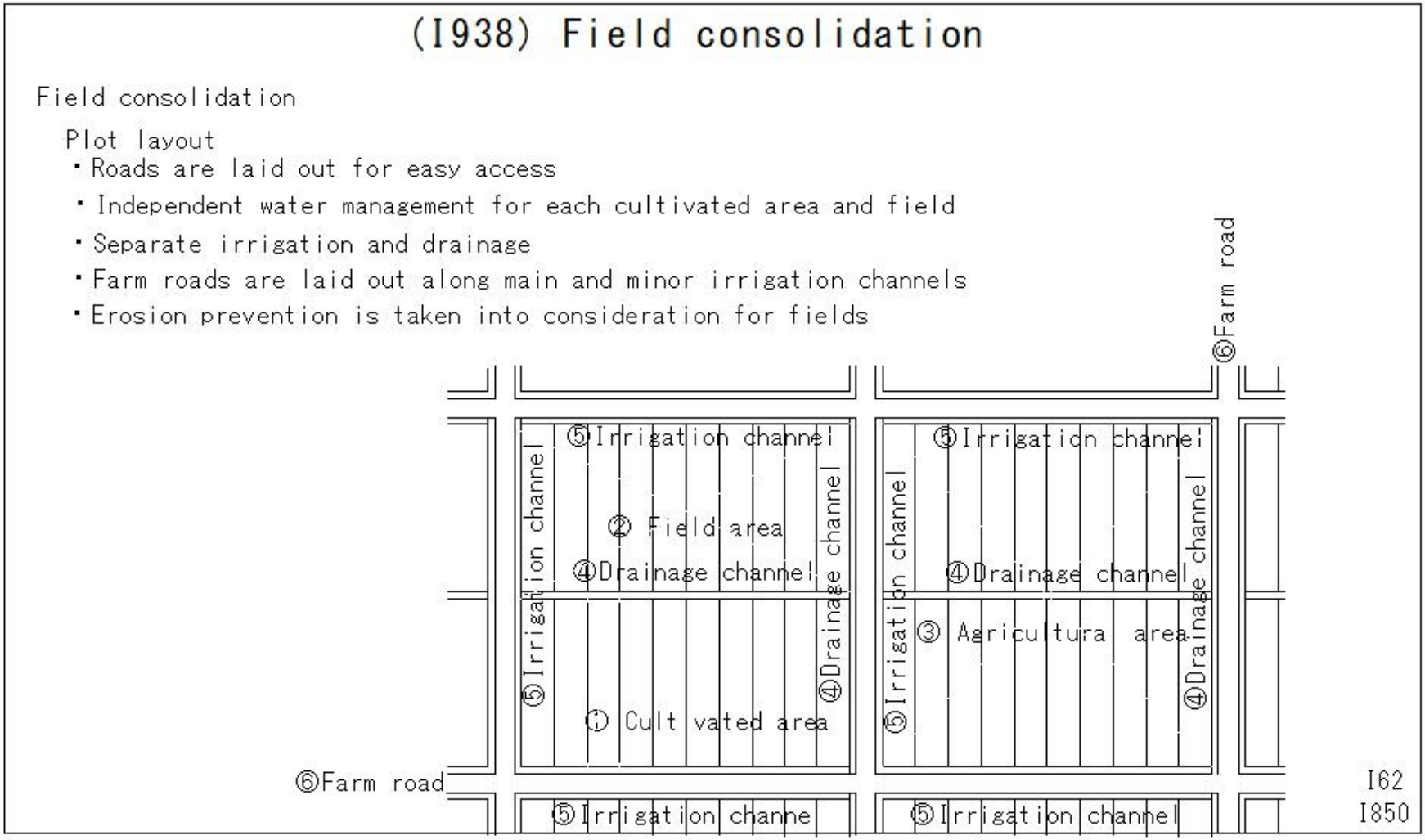
①Owned area: Plots owned by farmers

②Cultivated area: Plots that are a unit of mechanical work

③Plot: Plot surrounded by roads



(I938) Field consolidation

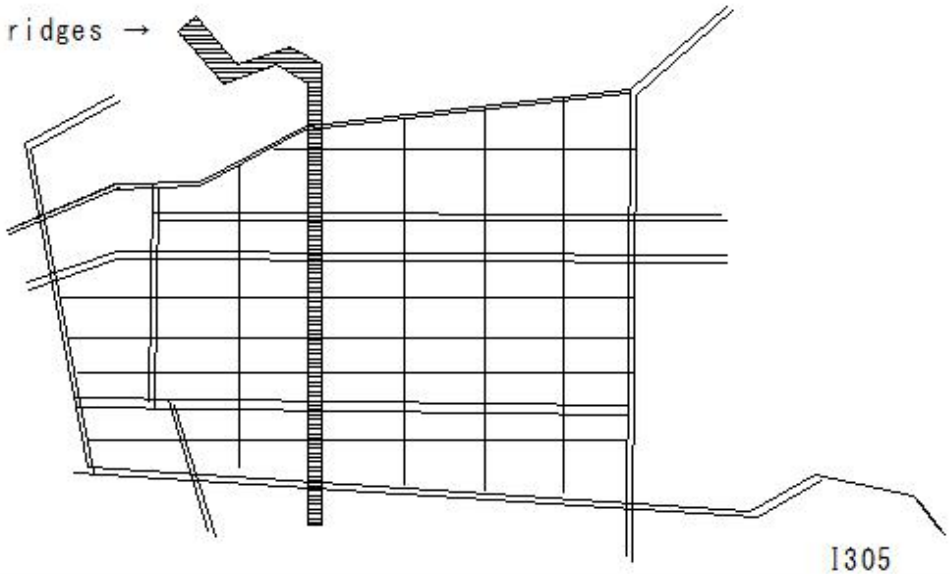


(I939) Field consolidation

(I939) Field consolidation

Field consolidation work

① Preparation for construction →
② Removal of debris and relocation of obstacles →
③ Temporary construction →
④ Stripping of topsoil →
⑤ Cutting of foundation→
⑥ Leveling of foundation →
⑦ Returning topsoil →
⑧ Construction of drainage channels and ridges →
⑨ Finishing of field surface →
⑩ Removal of temporary construction



I305

(I940) Field consolidation

(I940) Field consolidation

○ Land readjustment:

Small and irregularly shaped farmland plots are shaped to allow for work with large machinery.

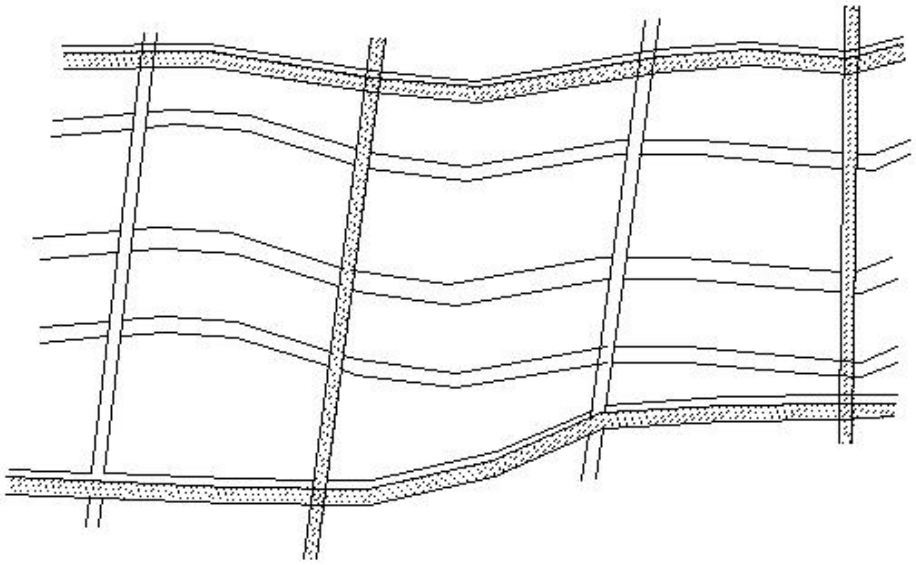
○ Farm road construction:

Smooth movement between farmlands and easy access to machinery.

○ Irrigation and drainage channel construction:

Proper water management is made possible, allowing rice paddies to be used as fields.

◯ Soil addition and underdrainage are also carried out.

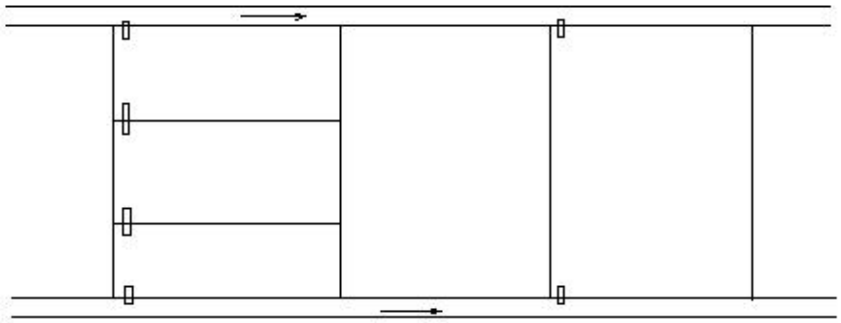


I306

(I941) Field consolidation

(I941) Field consolidation

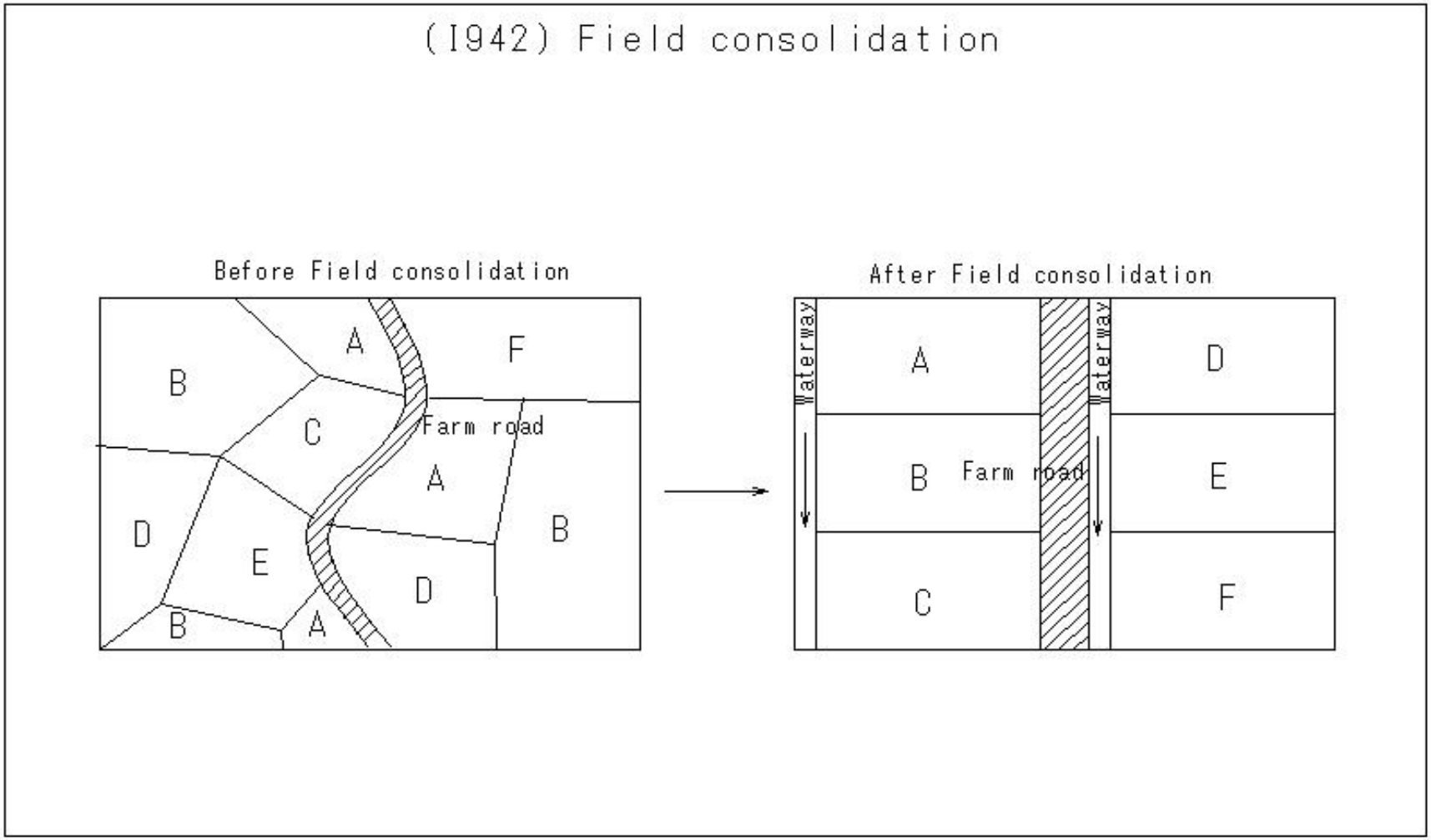
① Improve agricultural productivity
② Increase agricultural income
③ Improve food self-sufficiency
④ Efficient agricultural management
⑤ Farmers' application and consent
⑥ Consolidate scattered farmland
⑦ Enable efficient farm work
⑧ Use of large machinery



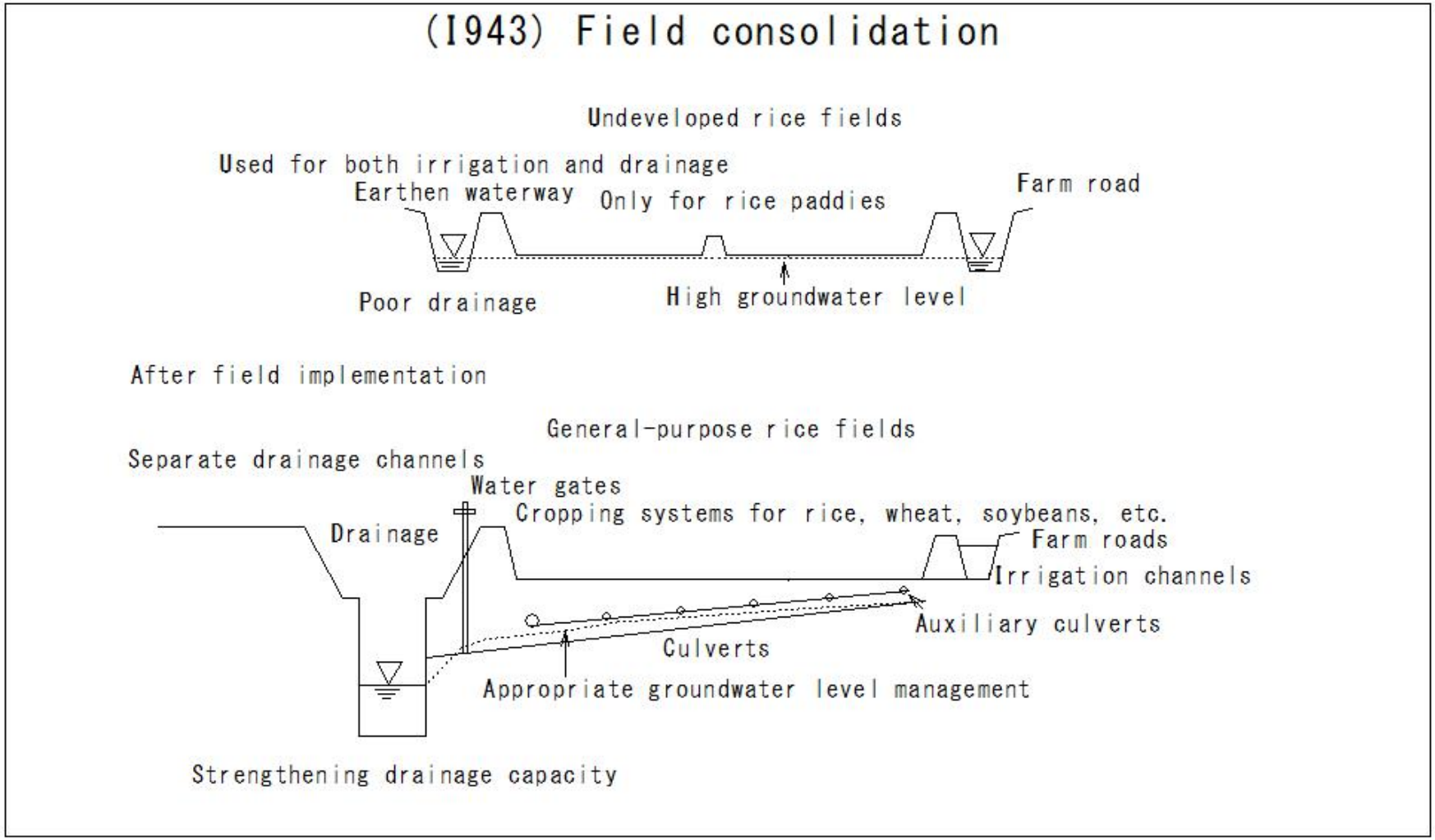
Field consolidation

I321

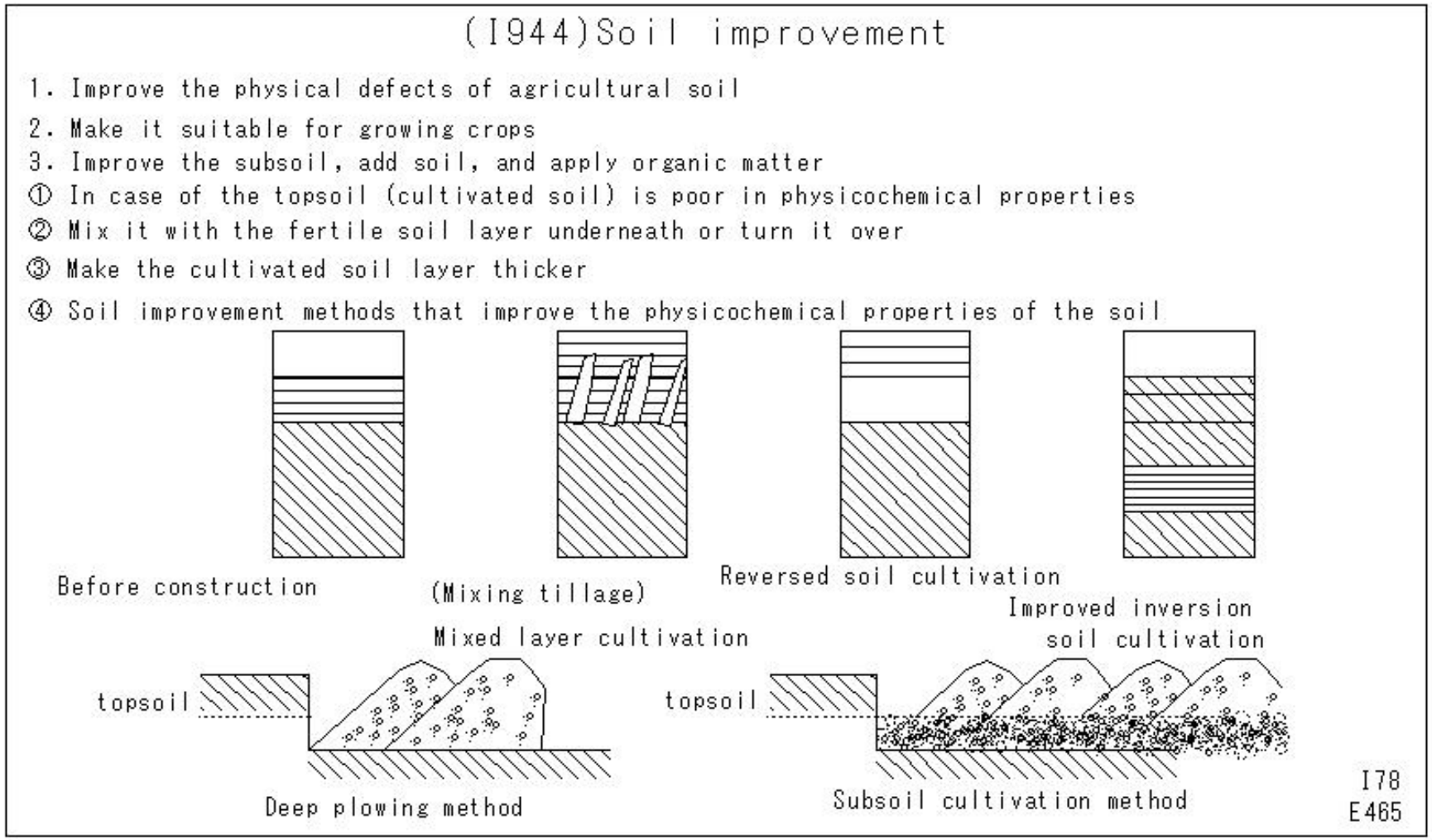
(I942) Field consolidation



(I943) Field consolidation



(I944)Soil improvement



(I945)Soil improvement

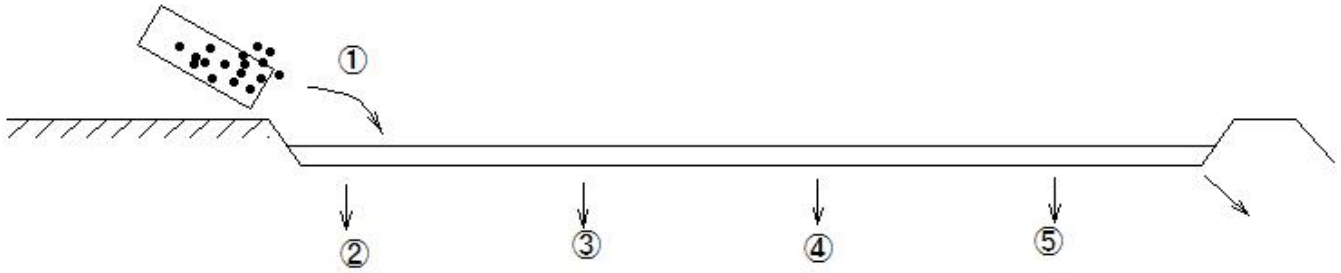
(I945)Soil improvement

1. Improve the physical defects of the soil
2. Efficiently supply the moisture, oxygen, and nutrients necessary for crop growth
3. Improve the efficiency of agricultural work

Degraded ferro-deficient paddy field

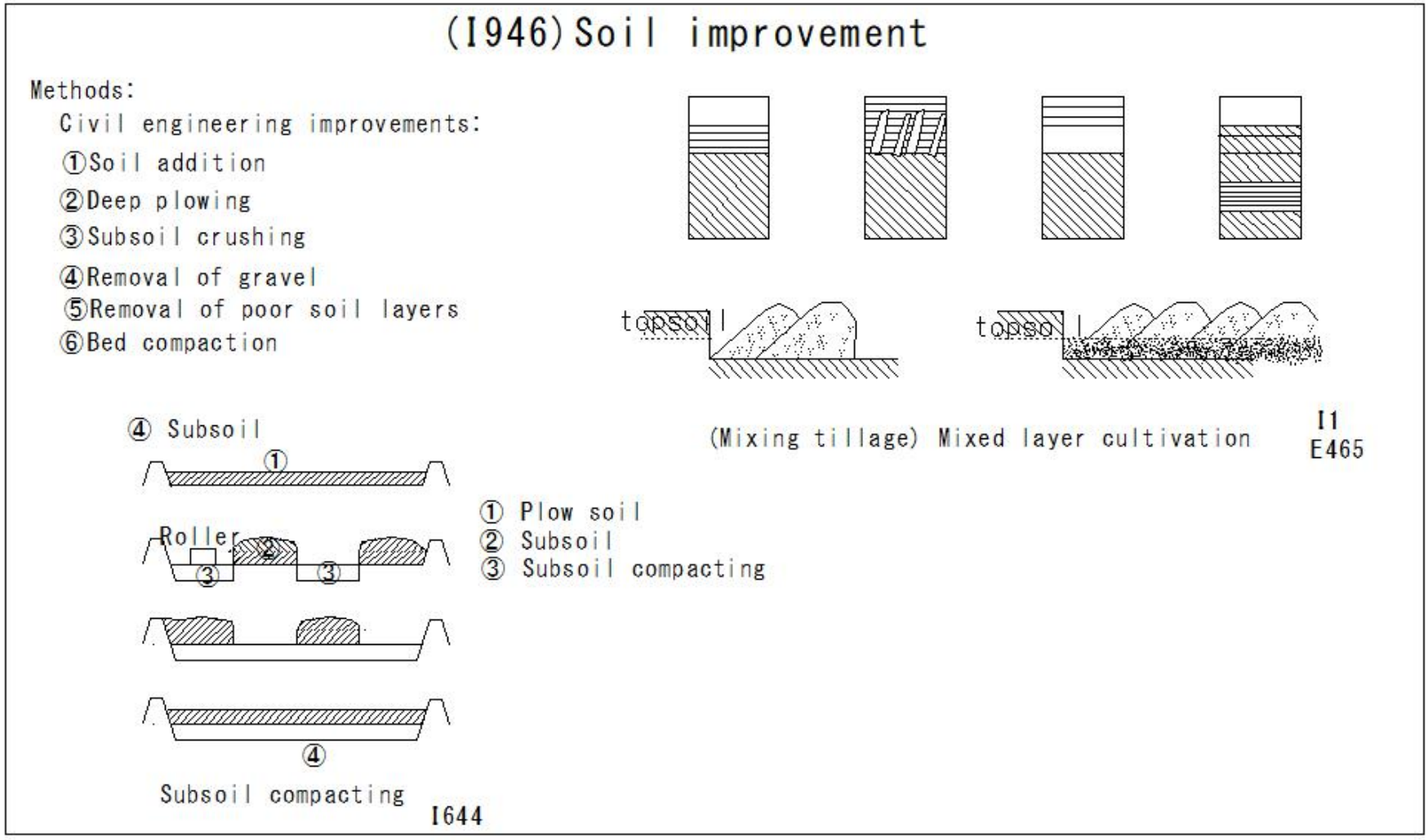
Degraded ferro-deficient paddy field are paddies where iron and other nutrients in the soil have leached out, adversely affecting rice growth.

①Soil addition
②Iron
③Manganese
④Lime
⑤Magnesium



I809

(I946)Soil improvement



(I947)Soil improvement

(I947)Soil improvement

Method

Application of organic matter

① Application of compost and organic matter

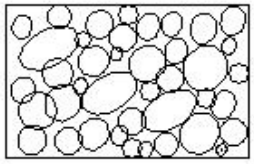
② Improve the soil's water retention, breathability, and granular structure

Use of soil improvement materials

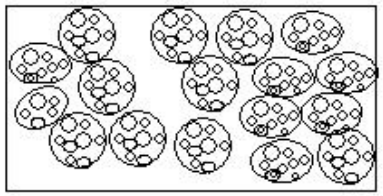
① Use pumice, lime, microbial materials, etc.

② Adjust the acidity of the soil

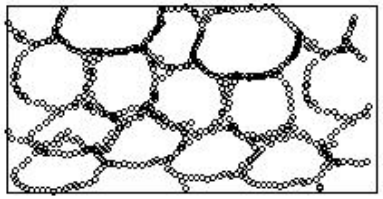
③ Form a granular structure



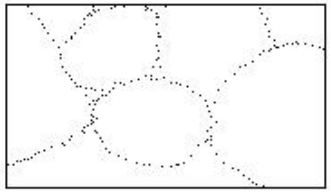
Single grained structure



Aggregate Structure



Honeycomb Structure



Flocculent Structure

Soil structure-Bonding of soil particles

E489

(I948)Soil improvement

(I948)Soil improvement

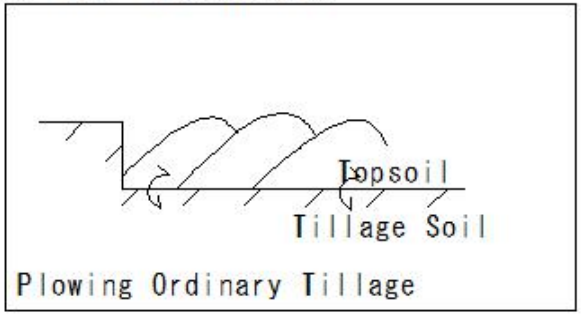
Benefits

①Improves the physical environment of the soil

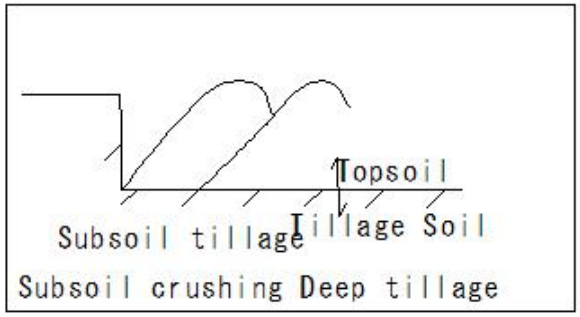
②Improves the efficiency of agricultural work

③Maintains soil health

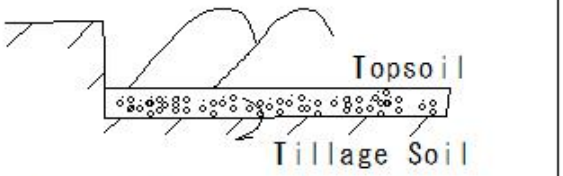
④Timing for soil improvement



Plowing Ordinary Tillage



Subsoil crushing Deep tillage



Subsoil crushing Deep tillage

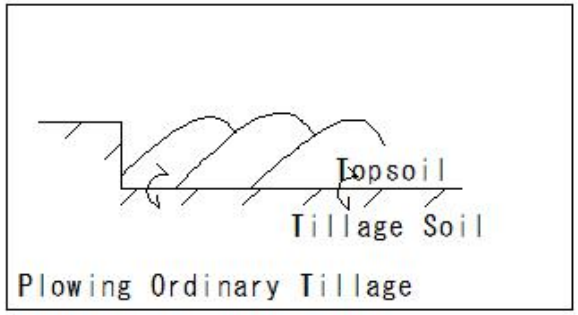
E490

(I949)Soil improvement

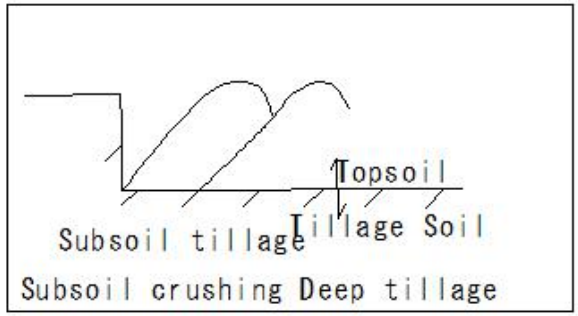
(I949)Soil improvement

① Soil addition:

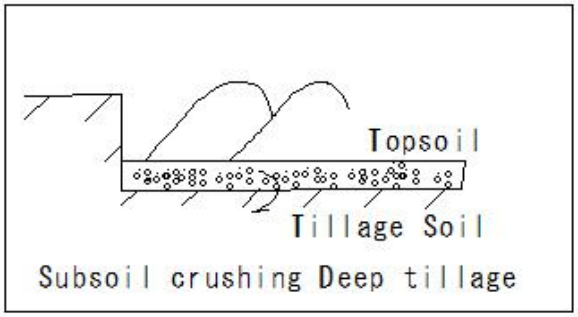
In case of the soil quality is poor, add good quality soil to improve the quality of the soil.



Plowing Ordinary Tillage



Subsoil crushing Deep tillage

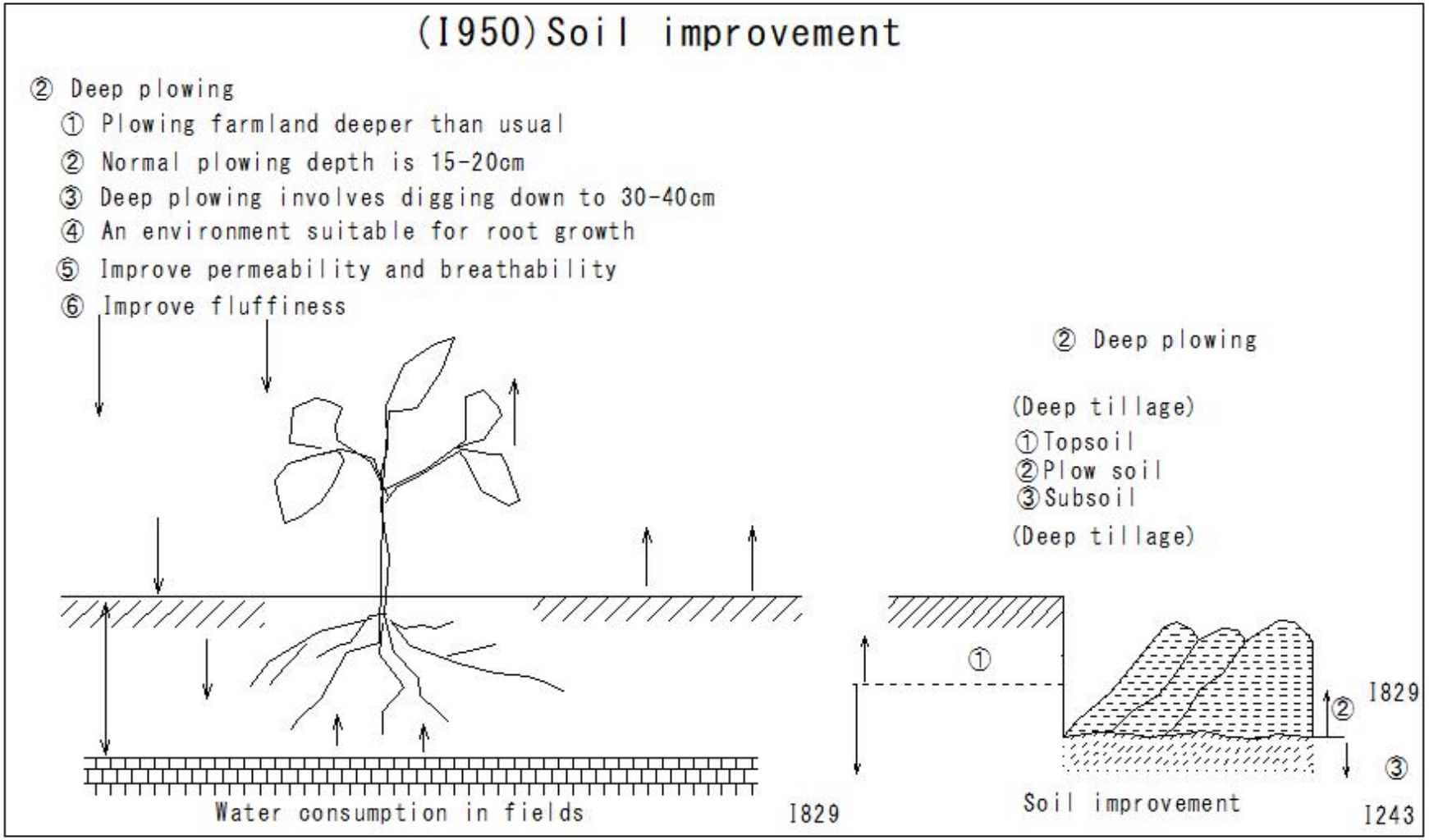


Subsoil crushing Deep tillage

Subsoil improvement

E490

(I950)Soil improvement



(I951)Soil improvement

(I951)Soil improvement

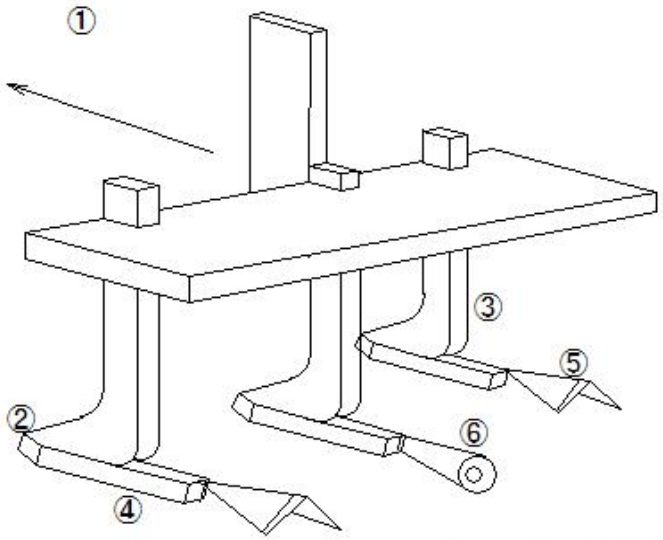
③ Subsoil crushing

① Crush the hardened soil layer (subsoil) under the topsoil in farmland and field soil

② Improve permeability and drainage

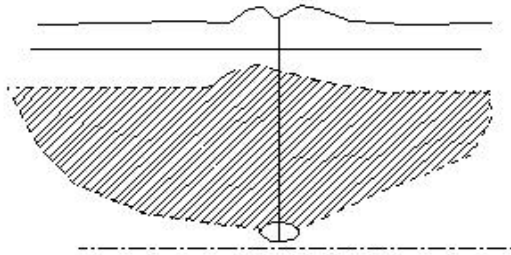
③ Create cracks about 60cm deep at regular intervals to create paths for water to pass through.

① Direction of travel
② Chisel
③ Pan breaker
④ Subsoiler
⑤ Wing
⑥ Hollow



Subsoil Breaker

I131



Subsoil Breaking

I130

(I952)Soil improvement

(I952)Soil improvement

④ Removal of gravel

Removing rock fragments by machine or by hand

○Purpose of gravel removal:

① Promoting crop growth:

② Preventing breakdowns of agricultural machinery:

③ Stabilizing the ground:

④ Ensuring the depth of the cultivated soil:

⑤ Improving the efficiency of agricultural machinery:

⑥ Stabilizing the ground:

○Disadvantages of gravel removal:

⑦ Cost:

⑧ Shifting of topsoil:

⑨ Mixing of subsoil:

○Points to note when removing gravel:

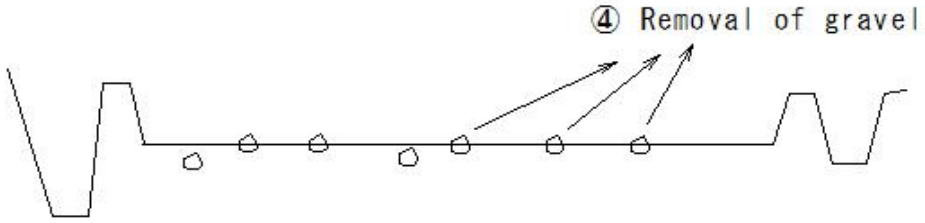
⑩ Safety of workers

⑪ Adequate preparation and planning

⑫ Consider the impact on the environment

⑬ Properly dispose of removed stones and gravel

⑭ Prepare the necessary machinery and tools for the work



Flushing irrigation

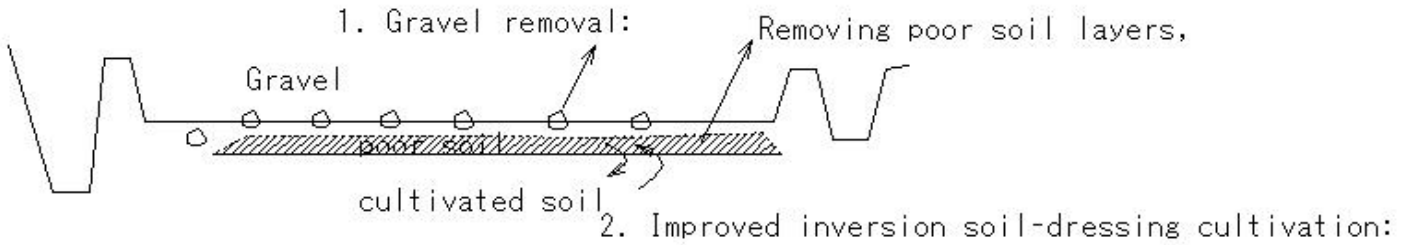
Paddy field irrigation methods

(I953)Soil improvement

(I953)Soil improvement

⑤ Removal of poor soil layers

Removing poor soil layers, increasing the thickness of cultivated soil, and increasing the effective soil depth.



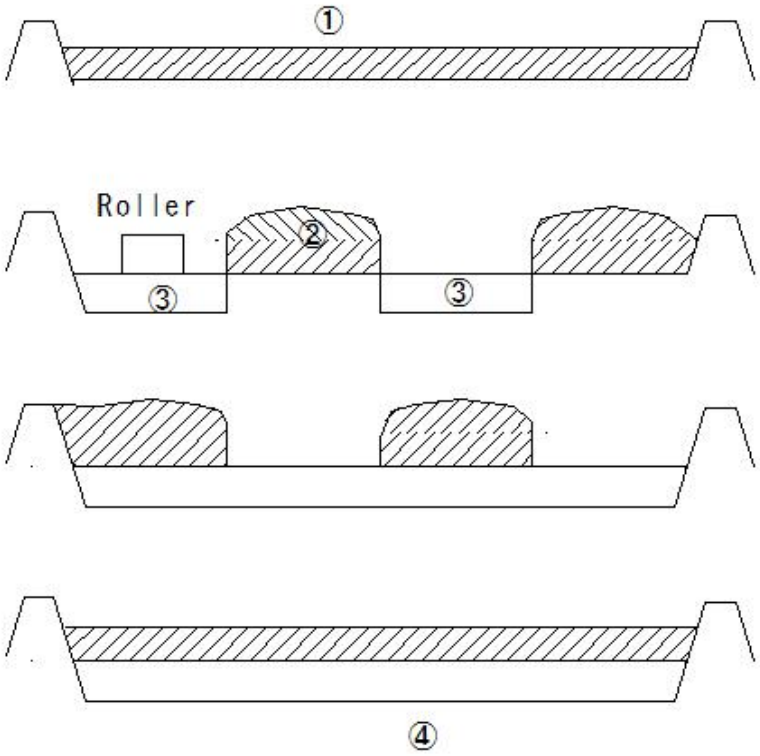
(I954)Soil improvement

(I954)Soil improvement

⑥ Tighten the bed
- ① Prevents water leakage
- ② Raises water and soil temperatures
- ③ Increases yields

Subsoil compacting
Compacting the soil layer to improve the permeability of paddy fields

- ① Plow soil
- ② Subsoil
- ③ Subsoil compacting
- ④ Subsoil

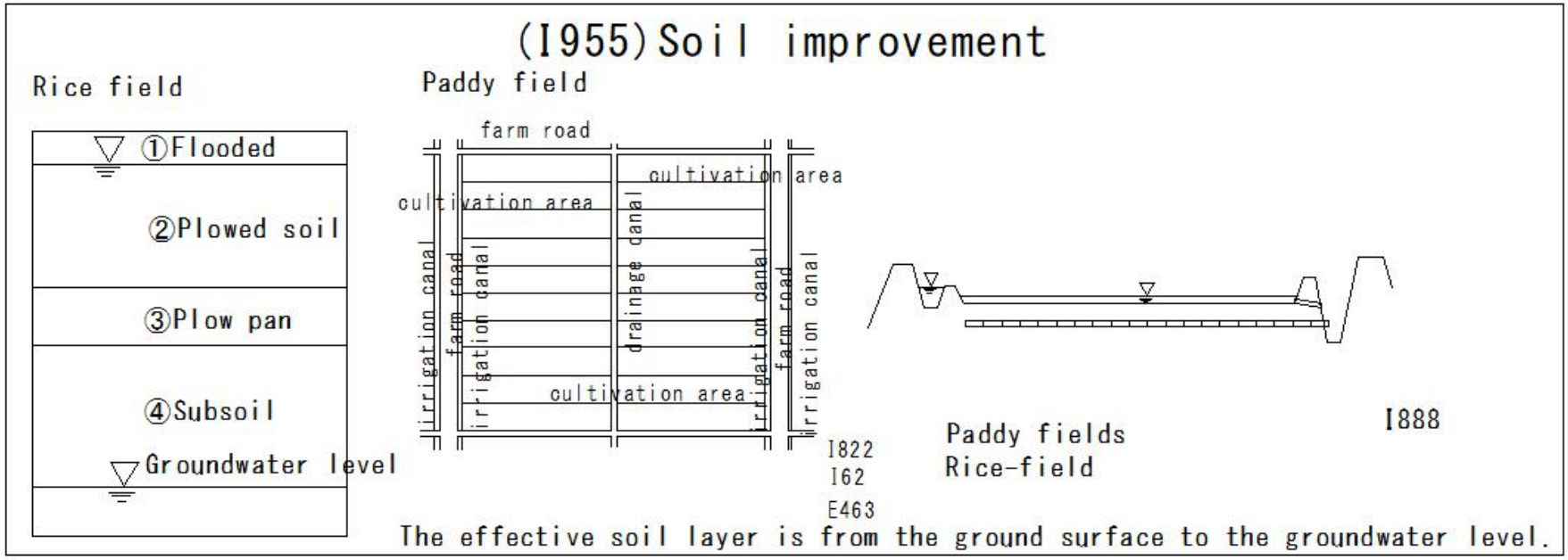


I644

(I955) Soil improvement

Improvement target for paddy soil layer

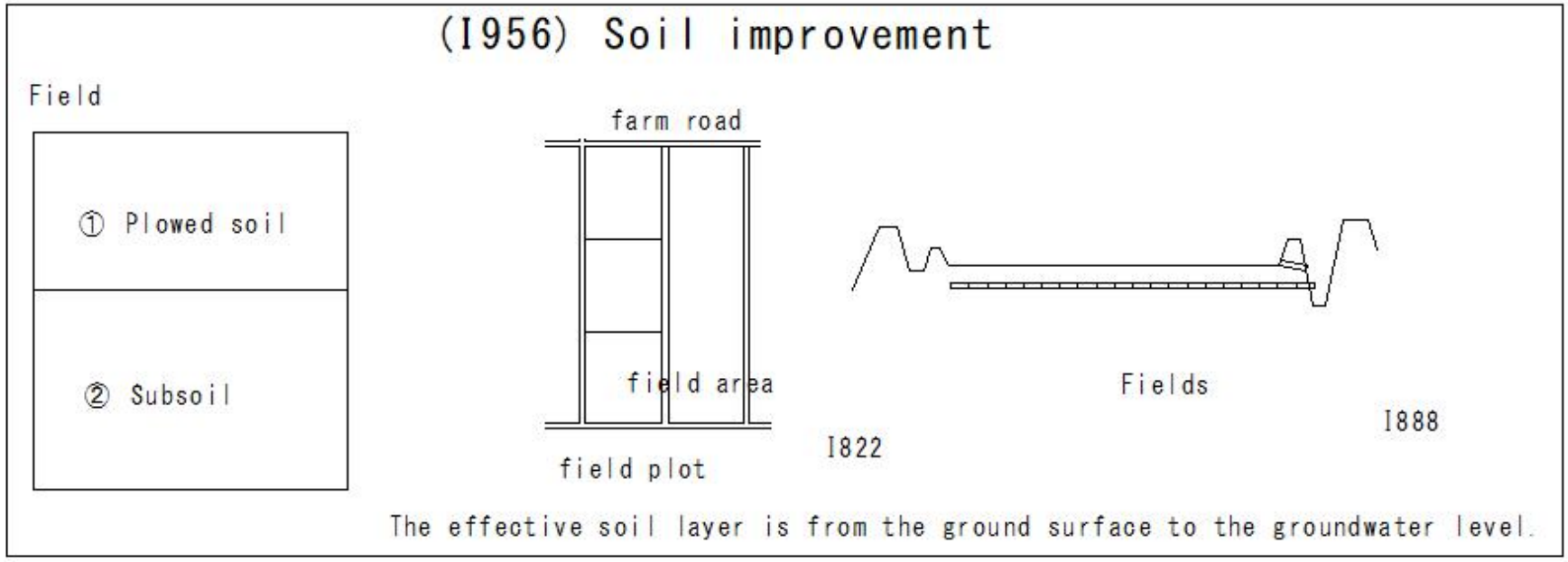
item	Ideal values	Tolerance values
①Soil quality	Loam to potted loam	Sandy loam to light loam
② Soil depth	15-20cm	10−20cm
③Effective soil layer	50cm or more	30cm or more
④Nikkei water depth	15-25mm/day	10-40mm/day
⑤Minimum hydraulic conductivity	Around 10^-5cm/s	Around 10^-4-10^-5cm/s



(I956) Soil improvement

Improvement target for ordinary field soil layer

Items	Ideal values	Tolerance values
① Soil type	Loam to potted loam	Sandy loam to light loam
② Thickness of cultivated soil layer	25cm or more	15cm or more
③ Thickness of effective soil layer	100cm or more	30cm or more
④ Porosity	60% or more	Normal soil 30-80%, black soil 40-90%
⑤ Permeability	50mm/24h	24mm/24h
⑥ Gravel	None	Volume 10%

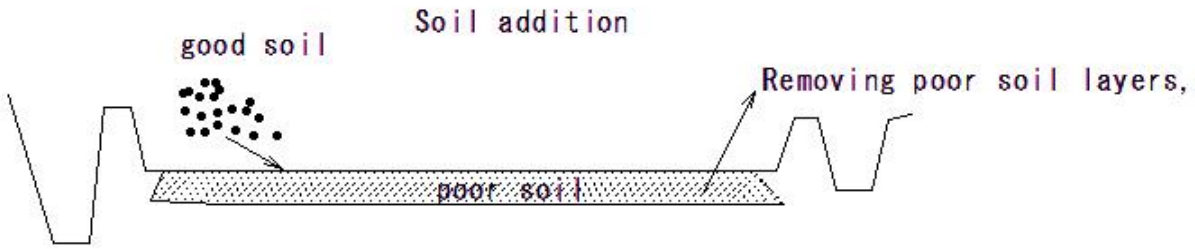


(I957)Soil improvement

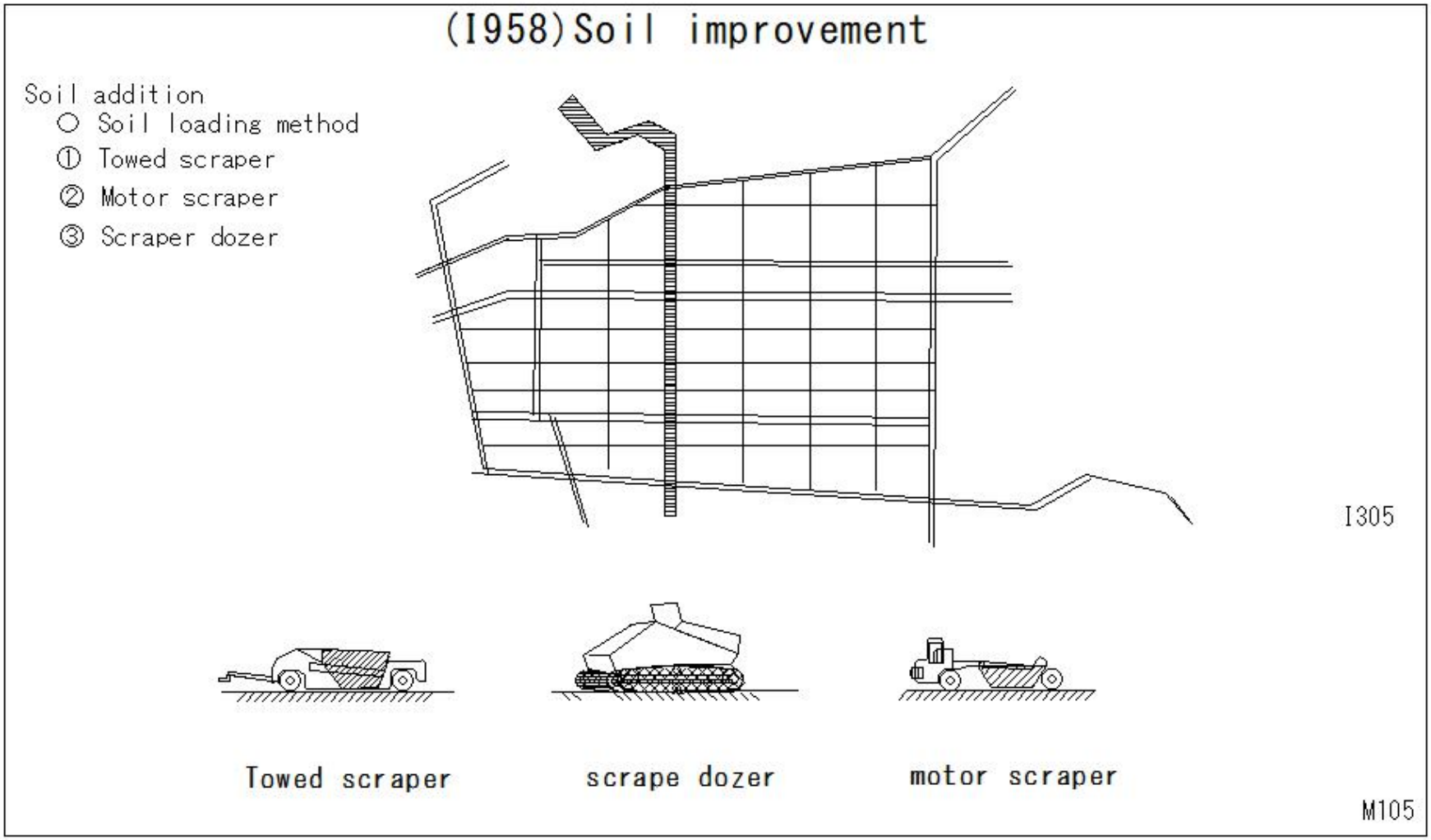
(I957)Soil improvement

Soil addition

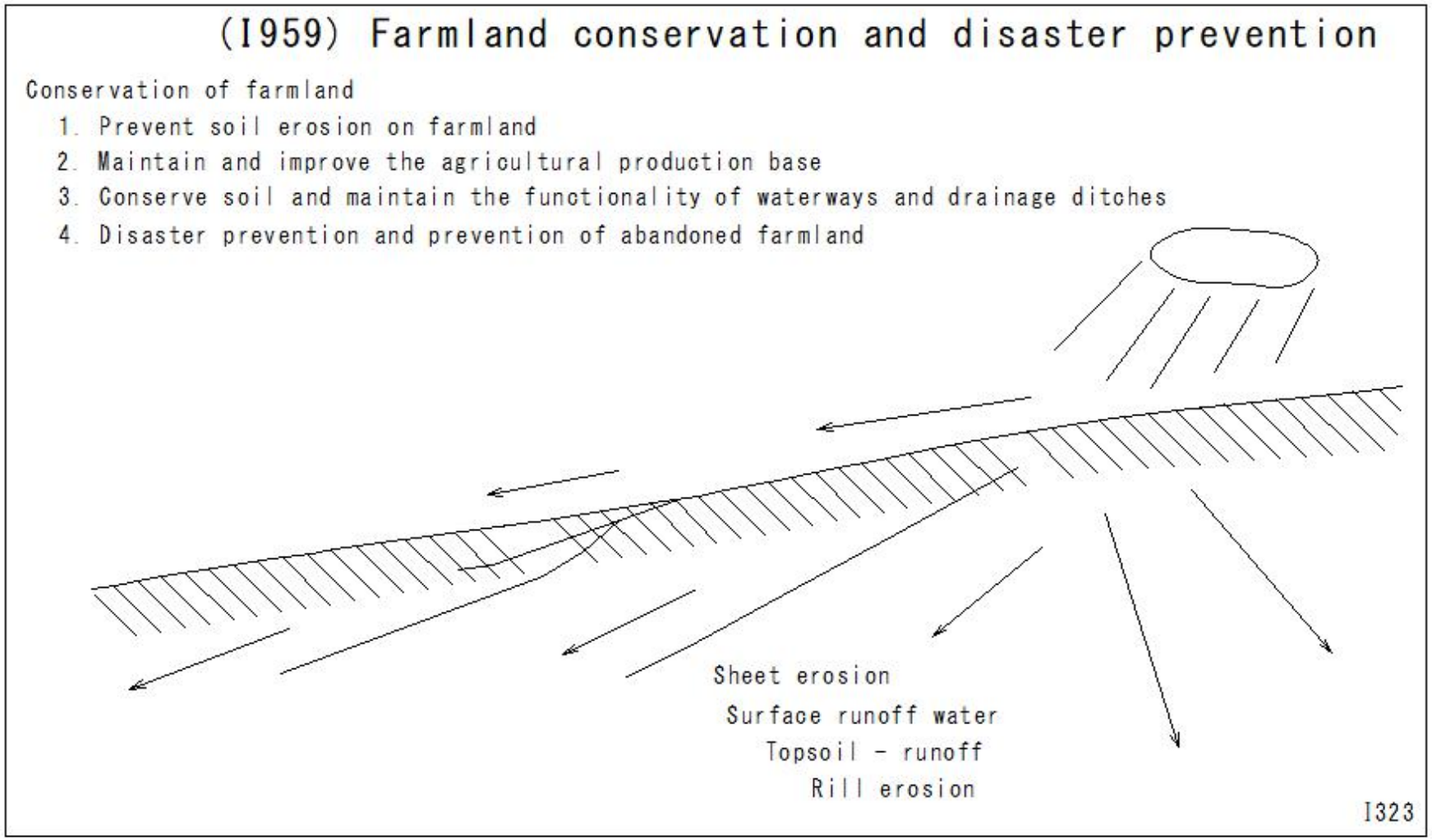
① Bringing in good soil from another place for land improvement and planting
② Improving poor ground
③ Creating soil suitable for plant growth
④ Ensuring the depth of the soil (cultivated soil) so that crop roots can grow
⑤ Improving problematic soil
⑥ Agriculture (promoting crop growth, improving the soil's nutritional balance, restoring soil pollution, etc.),
⑦ Improving soil bearing capacity
⑧ Clay soil addition, sandy soil addition, organic soil addition
⑨ There is a lot of water leakage from the rice paddies.
⑩ The rice paddies are old and dilapidated.



(I958)Soil improvement



(I959) Farmland conservation and disaster prevention

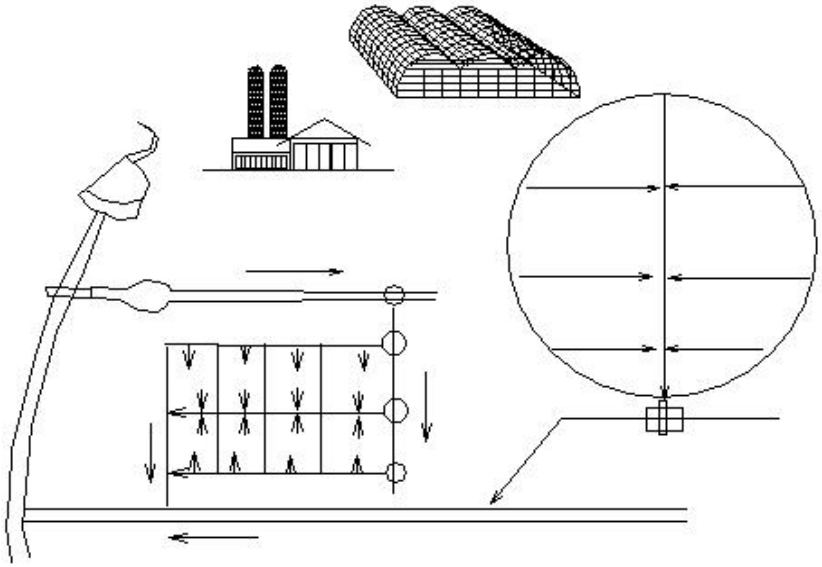


(I960) Farmland conservation and disaster prevention

(I960) Farmland conservation and disaster prevention

Maintaining the agricultural production base

1. Farmland is the source of food production and the foundation of agriculture.
2. By conserving the soil and water resources, we can achieve sustainable agriculture.



Layout of farmland and various facilities

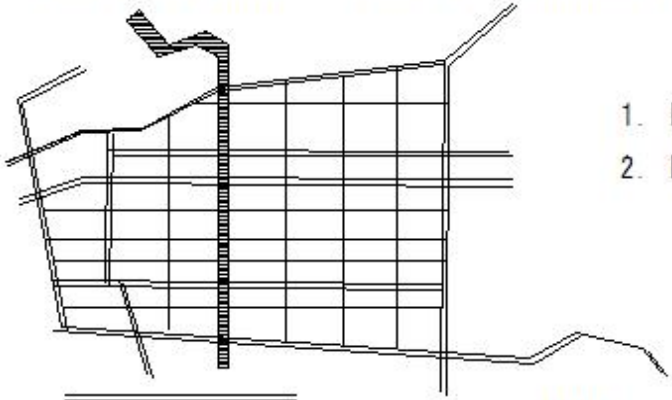
I334
1413
I818

(I961) Farmland conservation and disaster prevention

(I961) Farmland conservation and disaster prevention

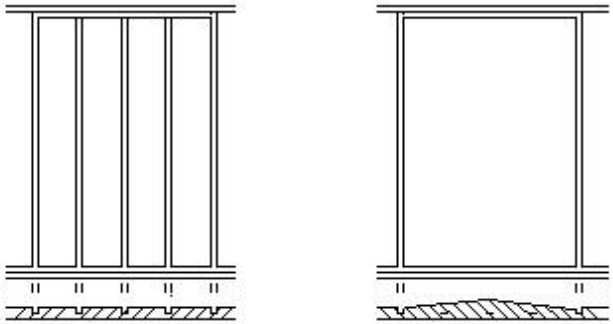
Environmental conservation

1. Preventing soil erosion : Prevents sediment runoff downstream and reduces water pollution.
2. Reducing abandoned farmland also contributes to maintaining biodiversity.

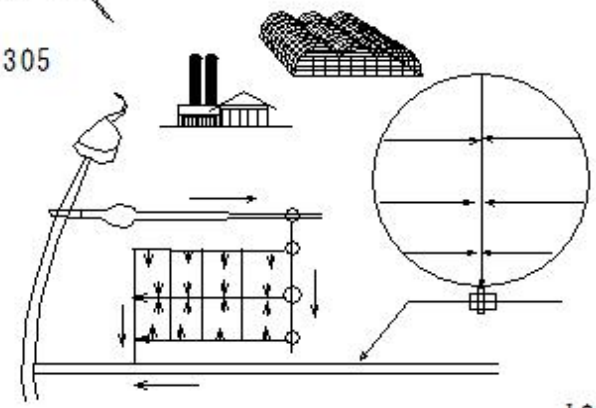


1. Preventing soil erosion
2. Reducing abandoned farmland

I305



I333



I334

(I962) Farmland conservation and disaster prevention

(I962) Farmland conservation and disaster prevention

Disaster prevention measures

○Farmland is an area that can be damaged in the event of floods or landslides

○It is also important to create disaster-resistant farmland by building embankments and taking measures against sloping land.

○Disaster prevention measures:

③Agricultural land is an area that may be damaged in the event of floods or landslides.

④Construction of embankments and measures for sloping land

○Specific examples of farmland conservation:

○Soil conservation:

⑤Installation of stone walls, planting, review of cultivation methods

○Construction of waterways and drainage ditches:

⑥Maintenance and repair of waterways and drainage ditches

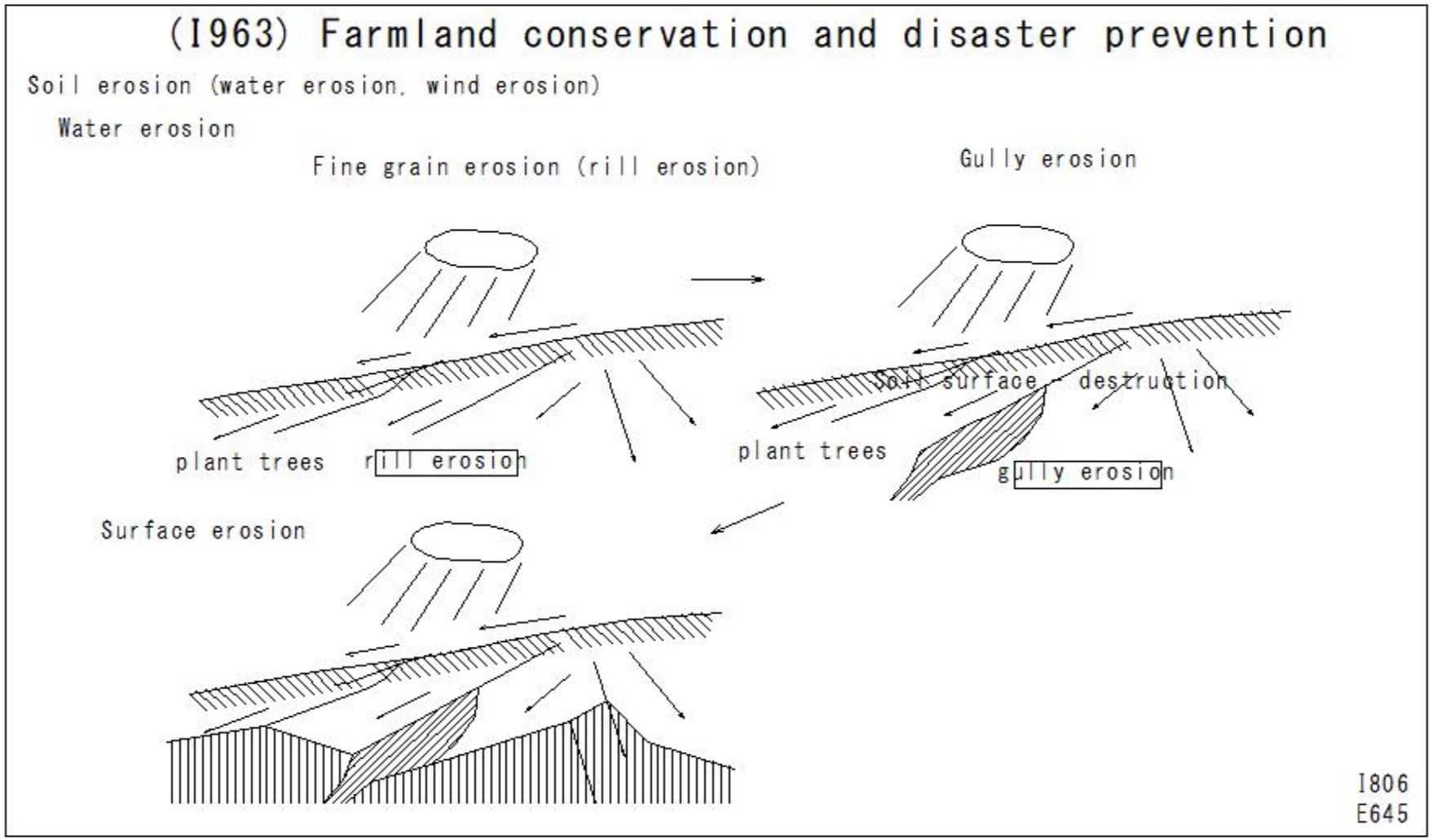
○Disaster prevention measures:

⑦Strengthening of embankments, measures for slopes, construction of evacuation routes

○Prevention of abandoned farmland:

⑧Reduction of abandoned farmland

(I963) Farmland conservation and disaster prevention



(I964) Farmland conservation and disaster prevention

(I964) Farmland conservation and disaster prevention

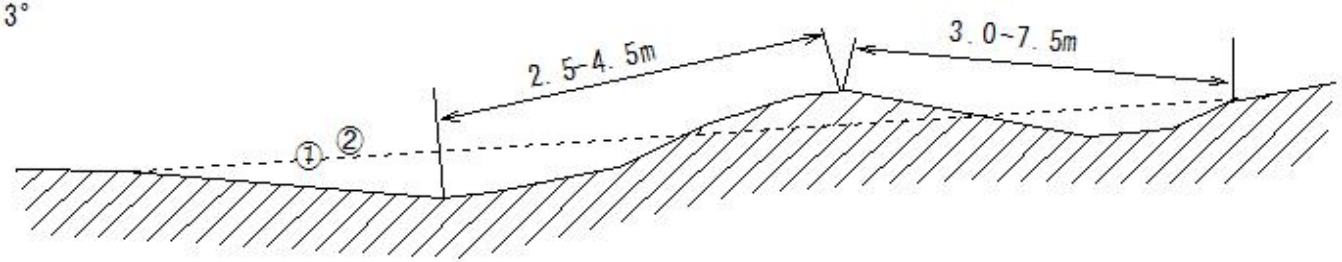
Soil erosion prevention

Terrace channel

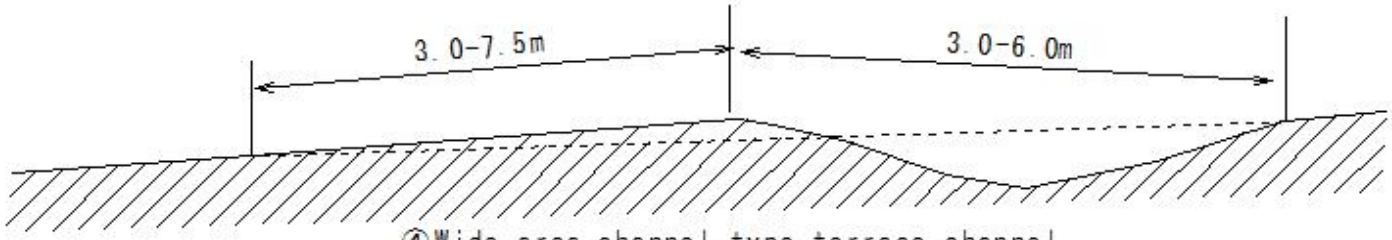
Prevention of soil runoff in large-scale sloping fields by introducing terrace channels, etc.

①Original ground

②Slope 3°



③Ridge-type terrace channel

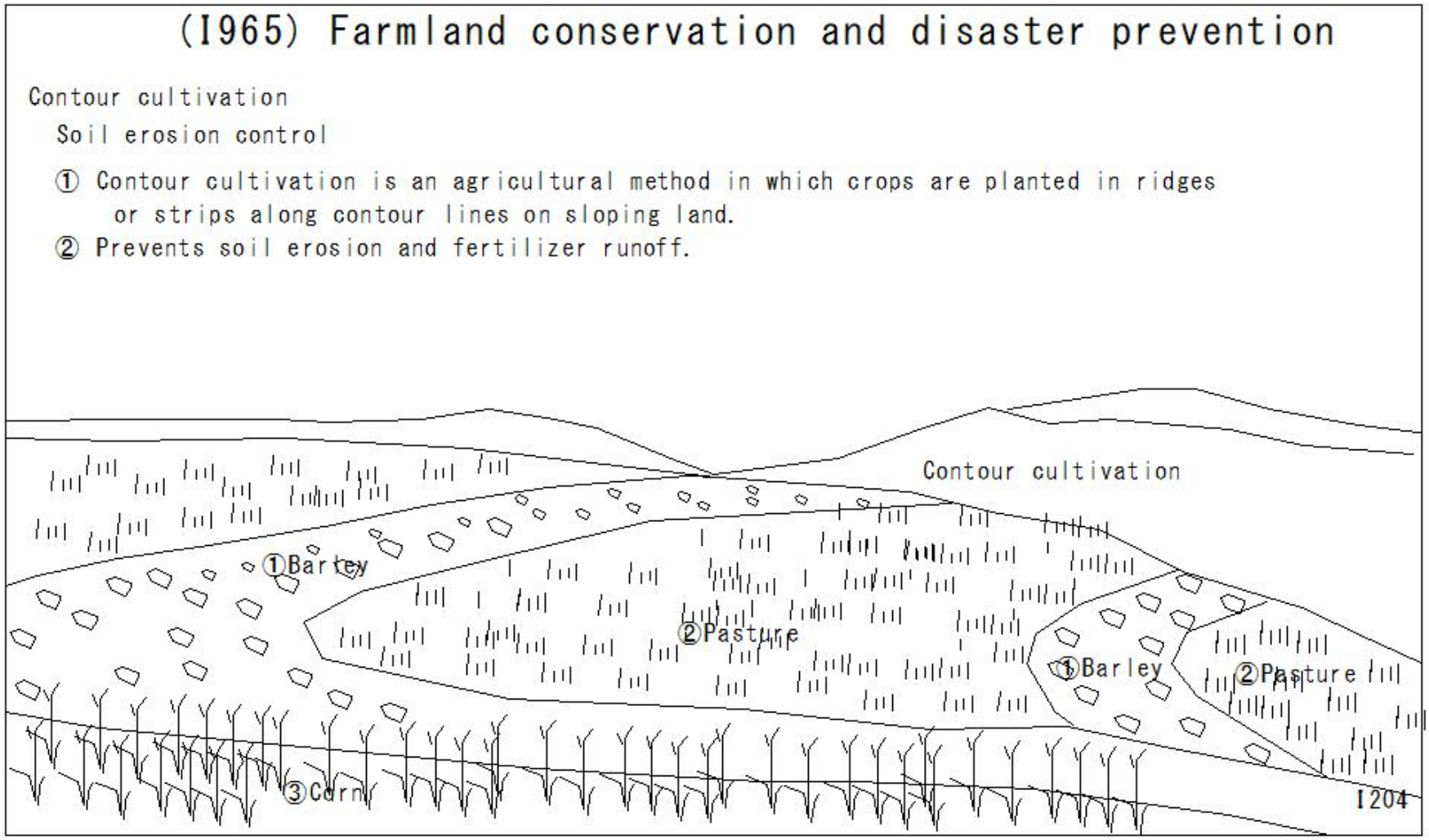


④Wide-area channel-type terrace channel

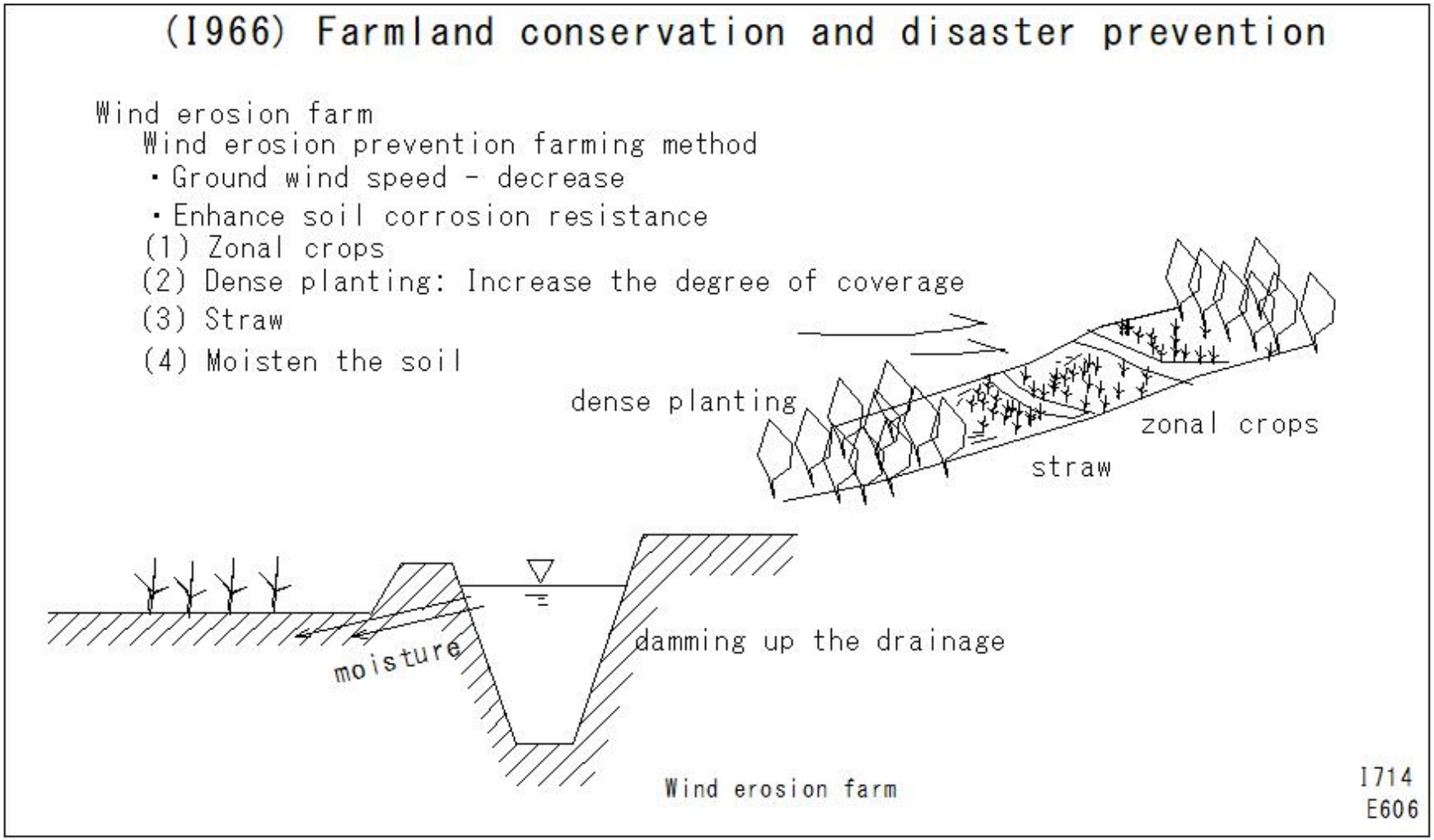
Terrace channel

I201

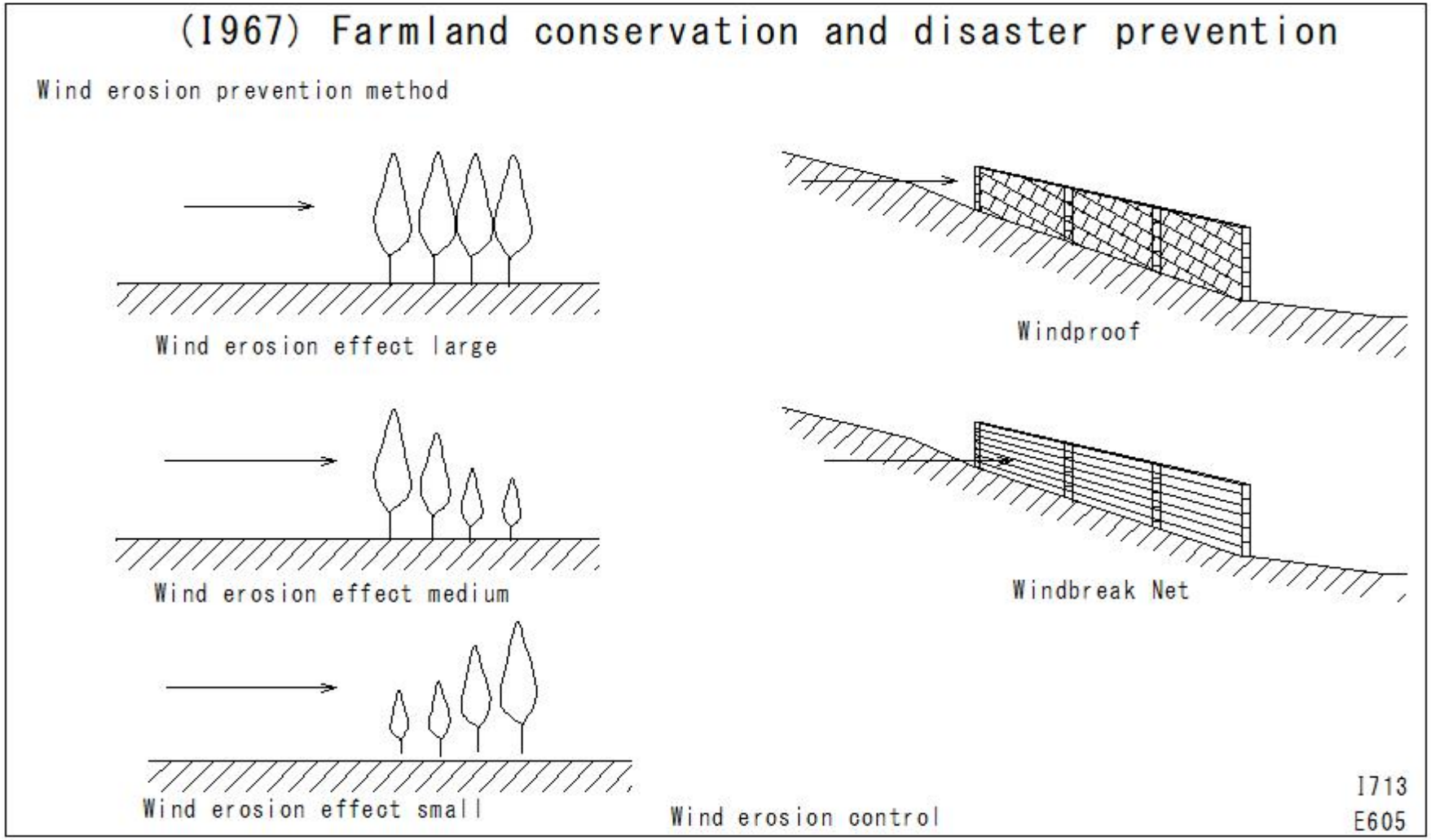
(I965) Farmland conservation and disaster prevention



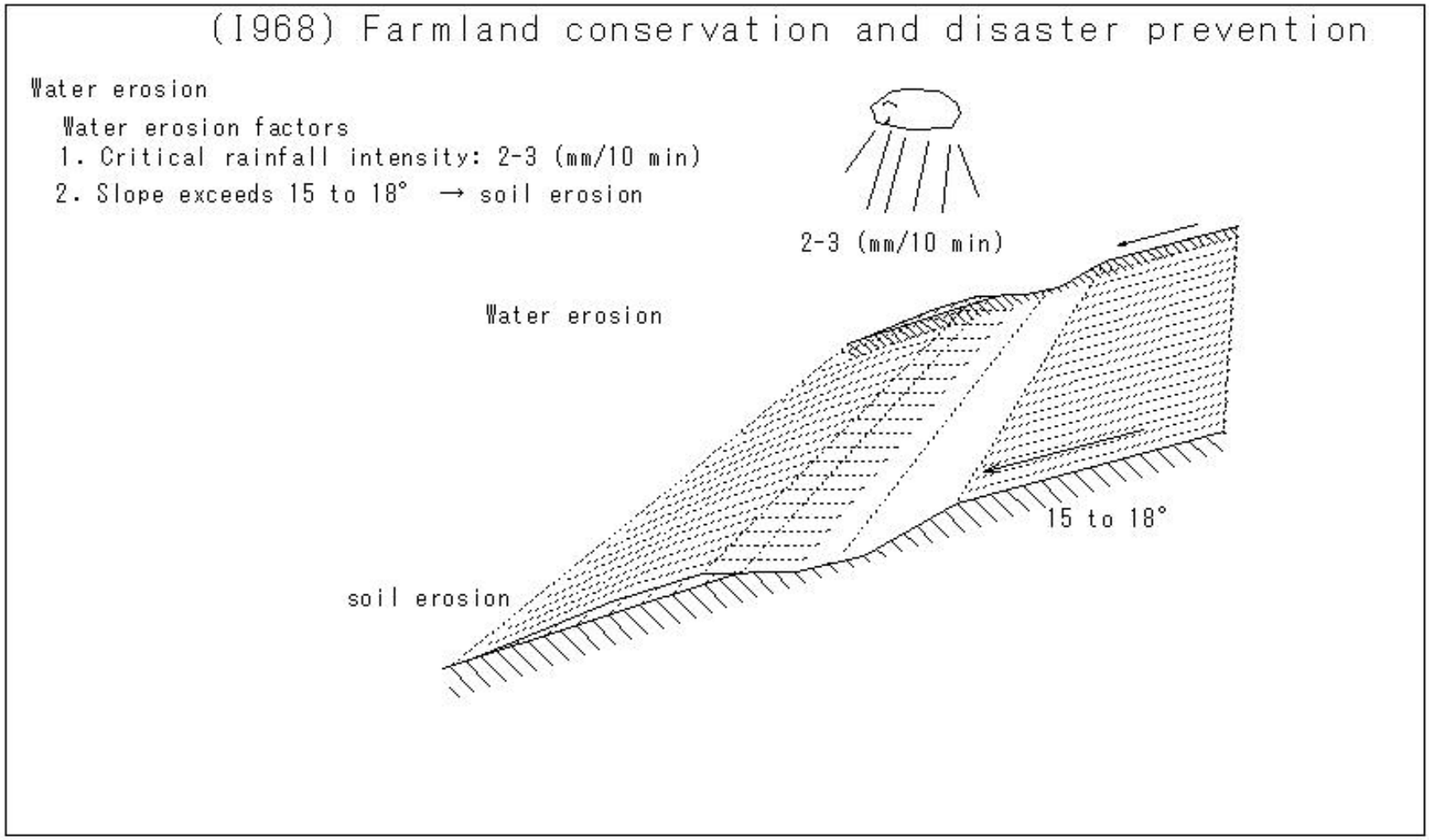
(I966) Farmland conservation and disaster prevention



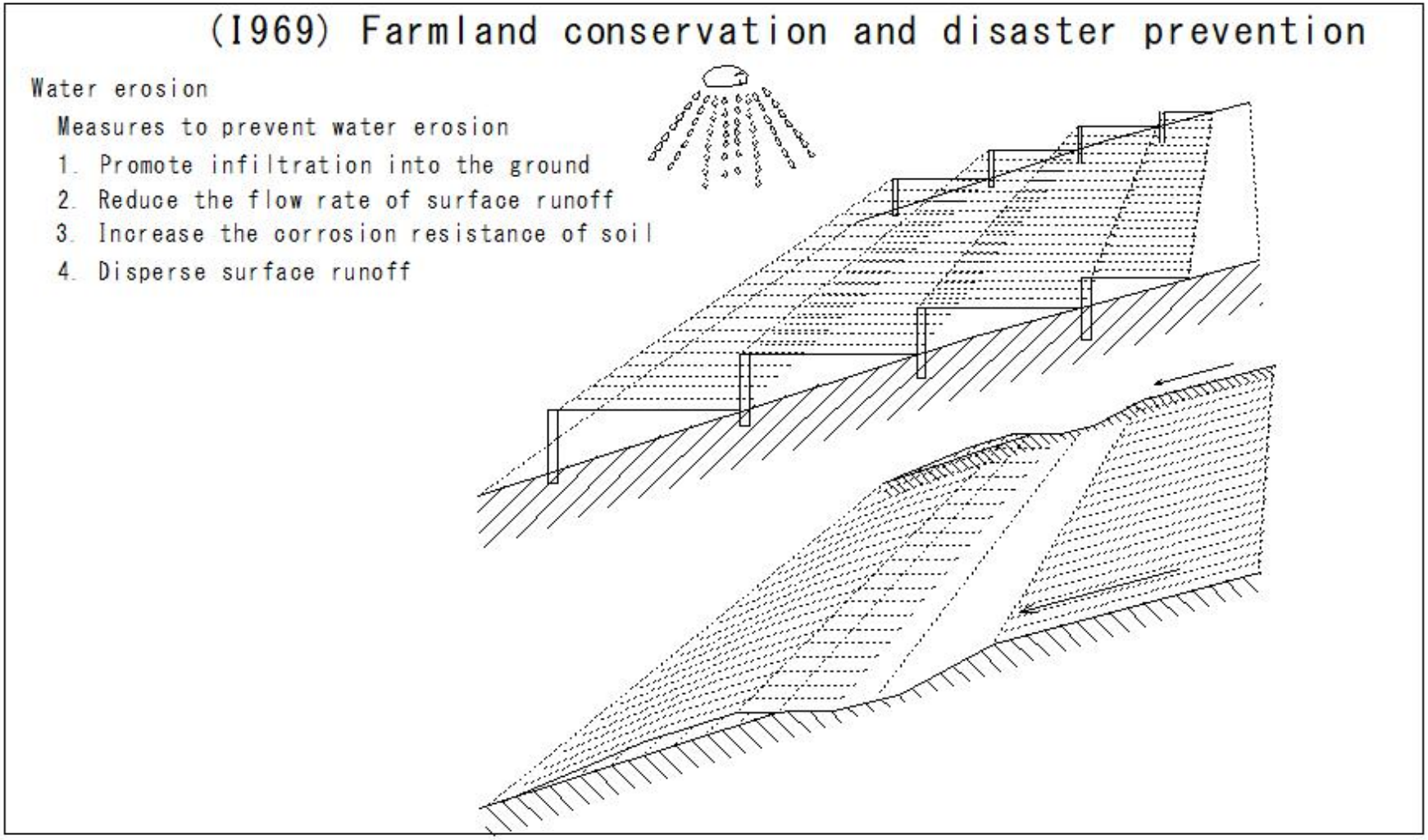
(I967) Farmland conservation and disaster prevention



(I968) Farmland conservation and disaster prevention



(I969) Farmland conservation and disaster prevention



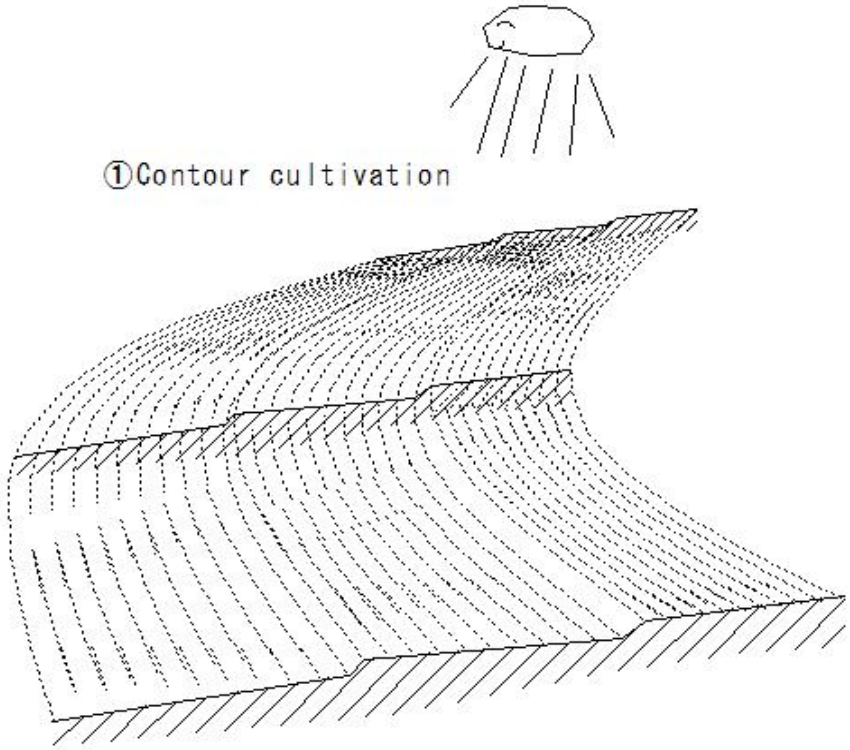
(I970) Farmland conservation and disaster prevention

(I970) Farmland conservation and disaster prevention

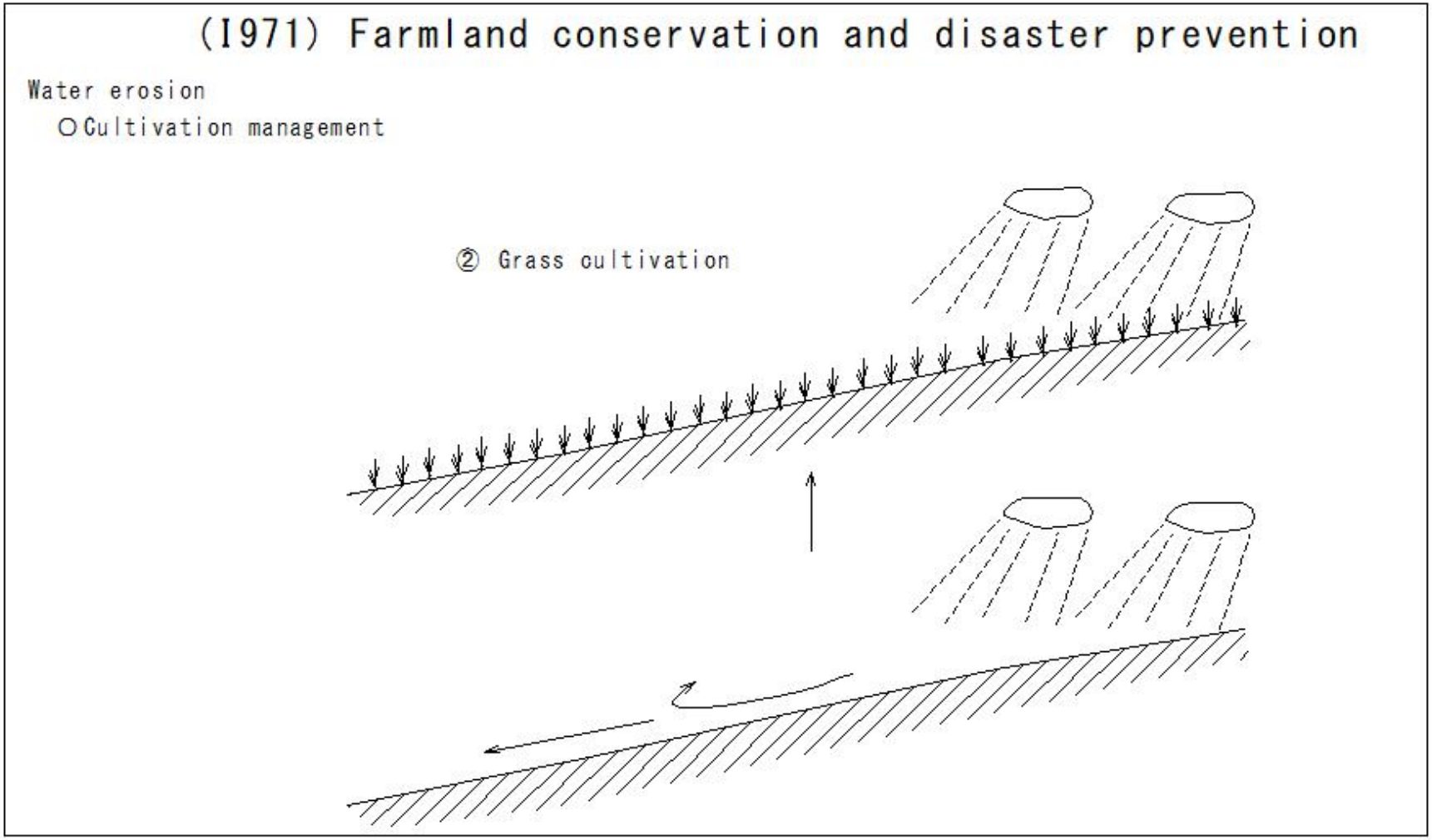
Water erosion

○Cultivation management

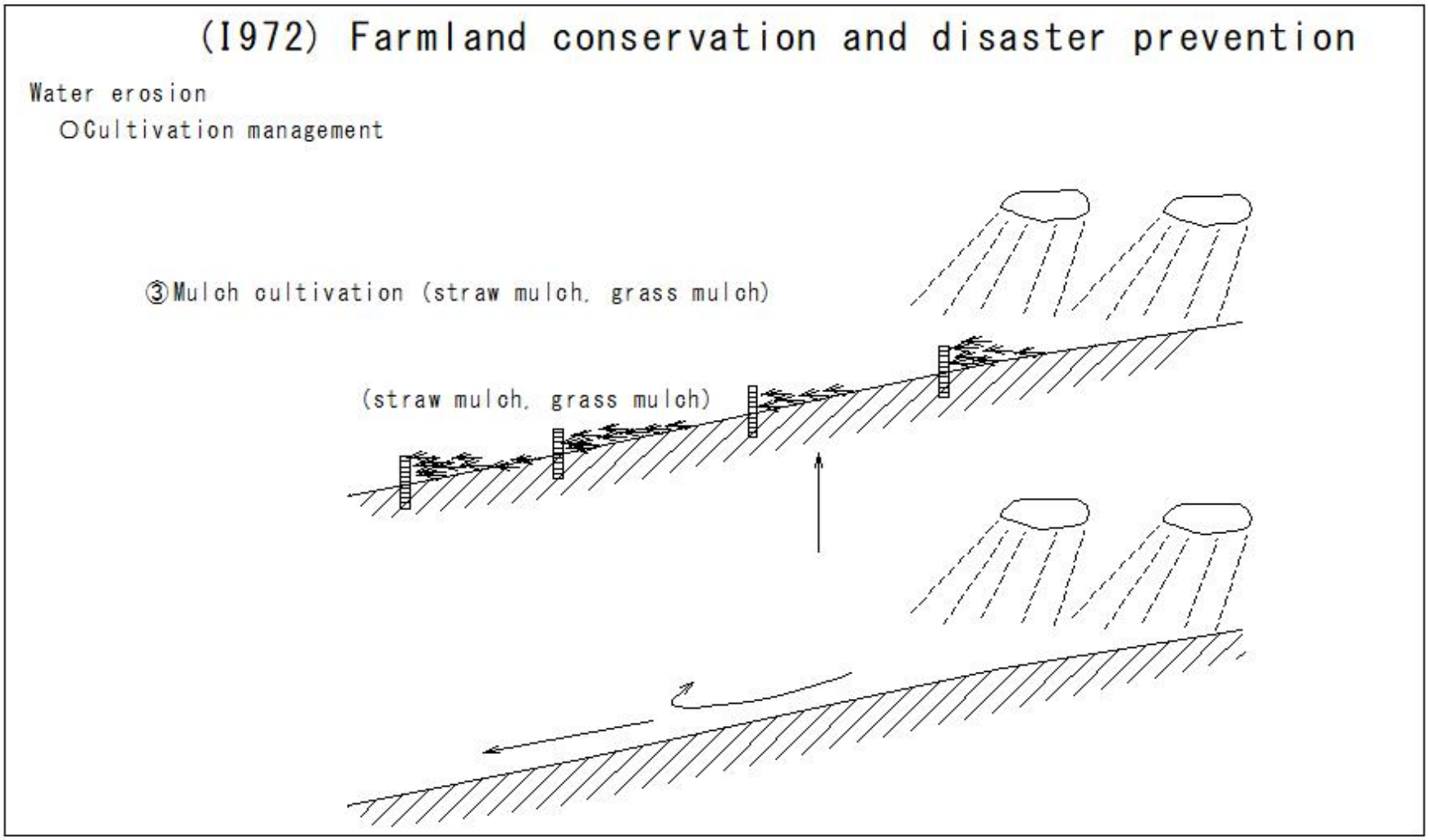
①Contour cultivation



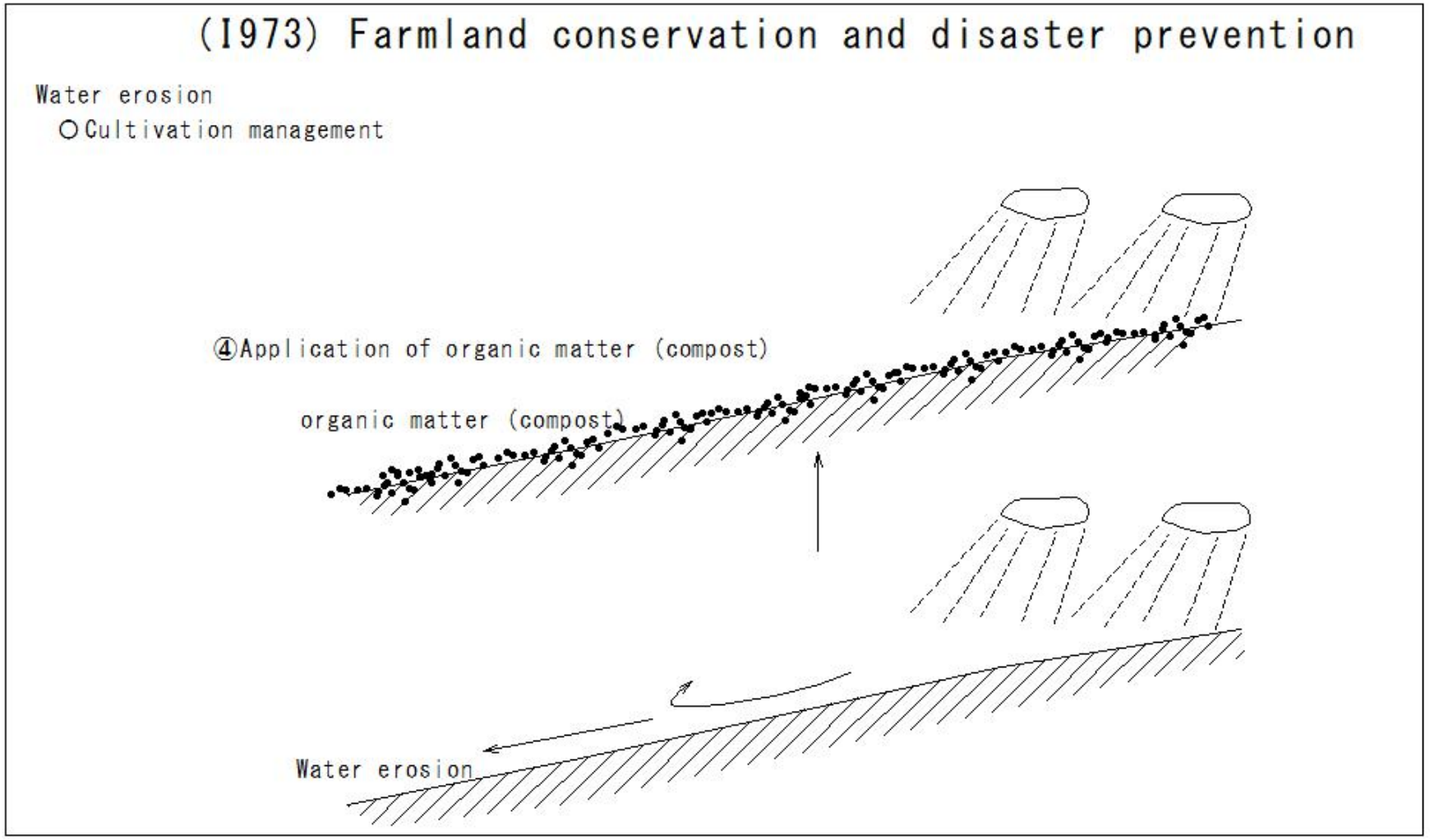
(I971) Farmland conservation and disaster prevention



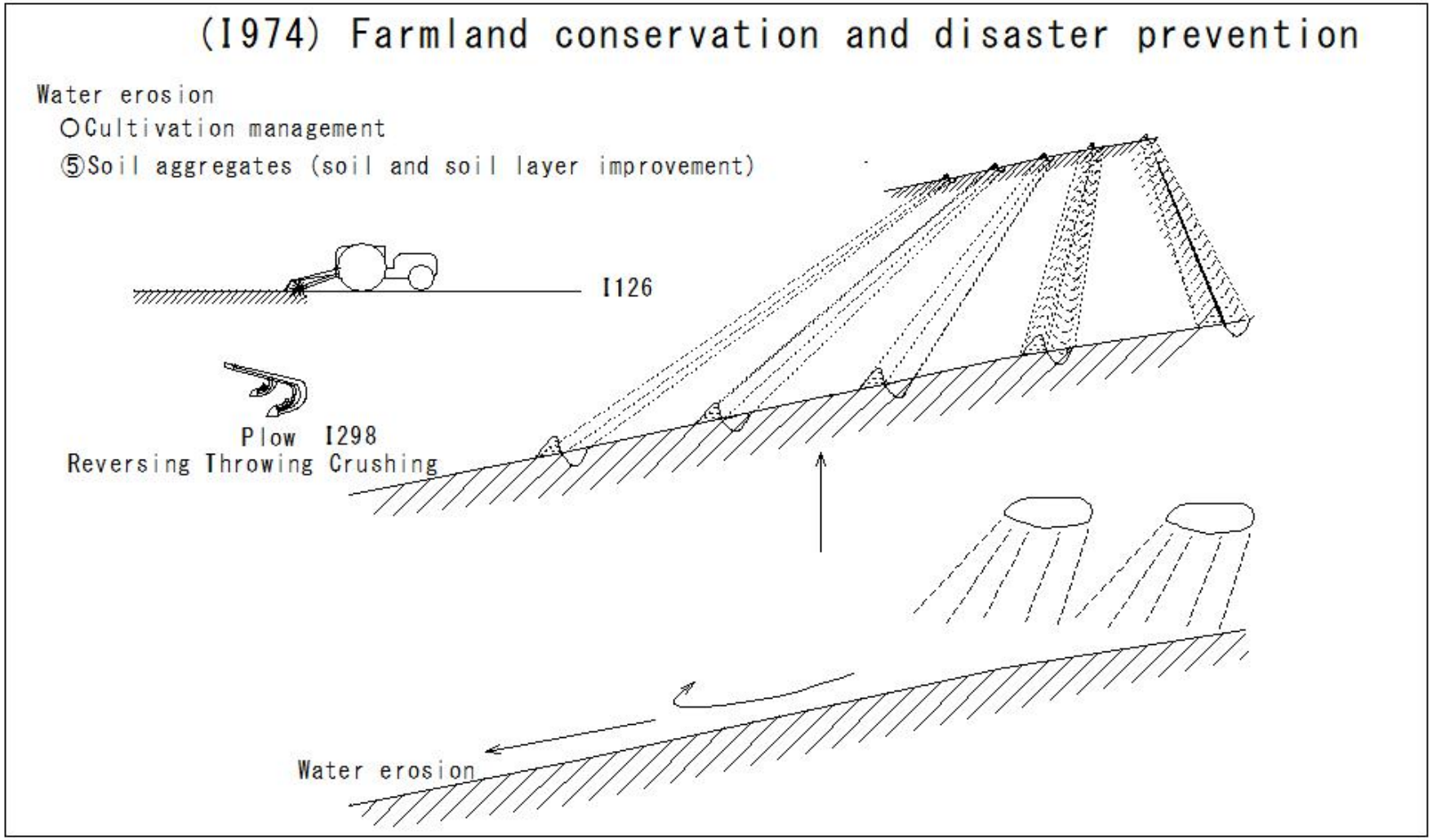
(I972) Farmland conservation and disaster prevention



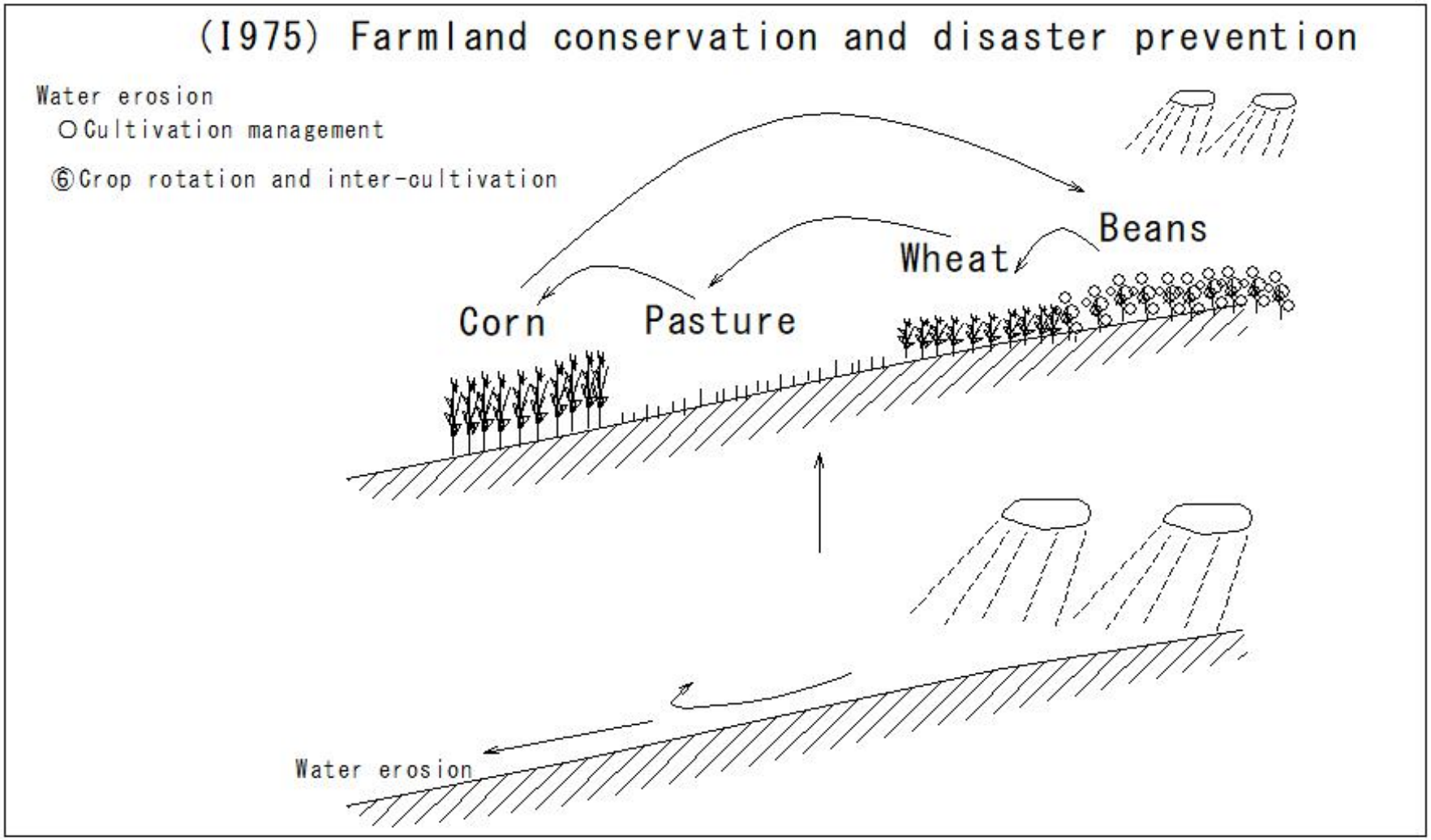
(I973) Farmland conservation and disaster prevention



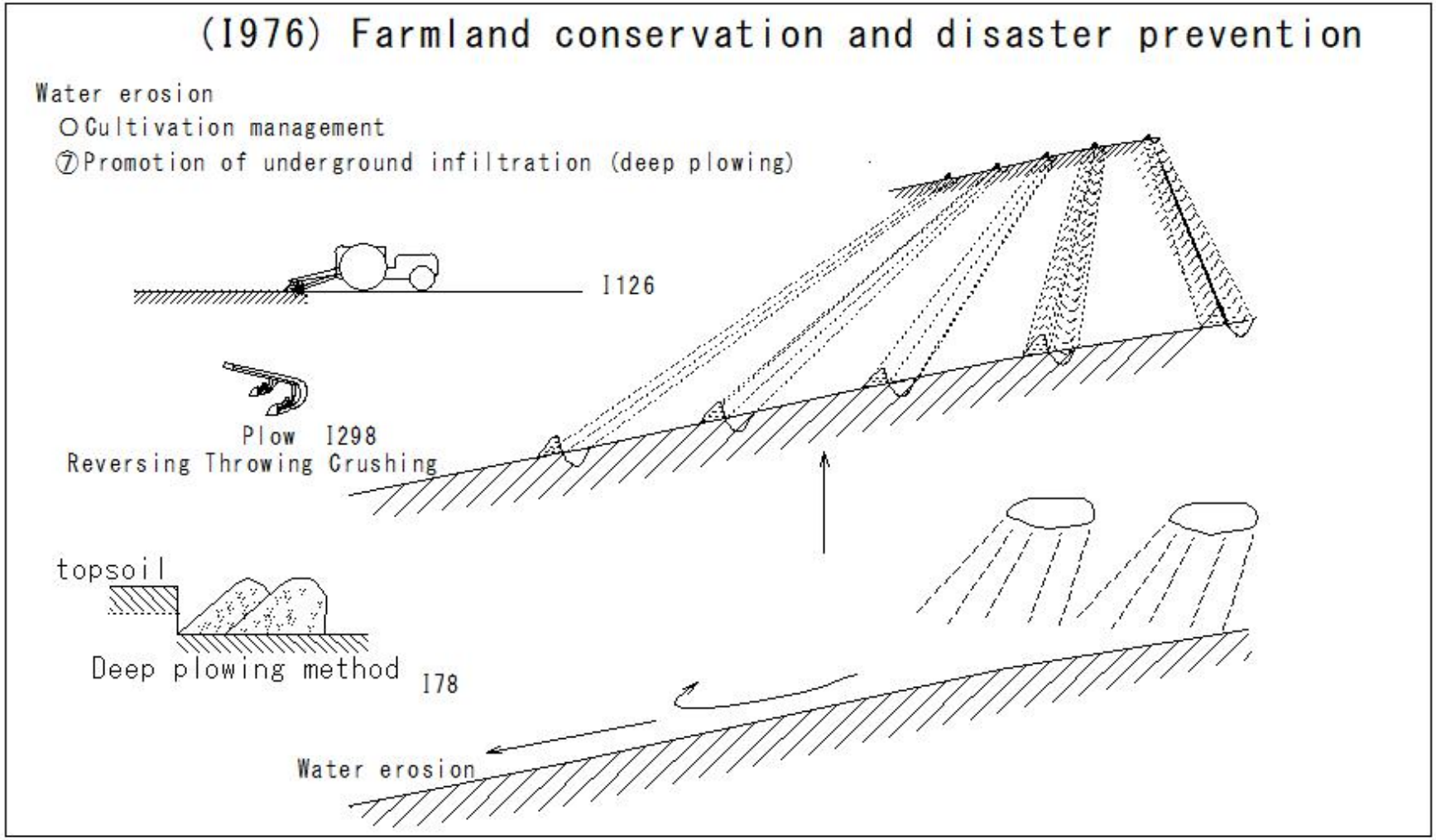
(I974) Farmland conservation and disaster prevention



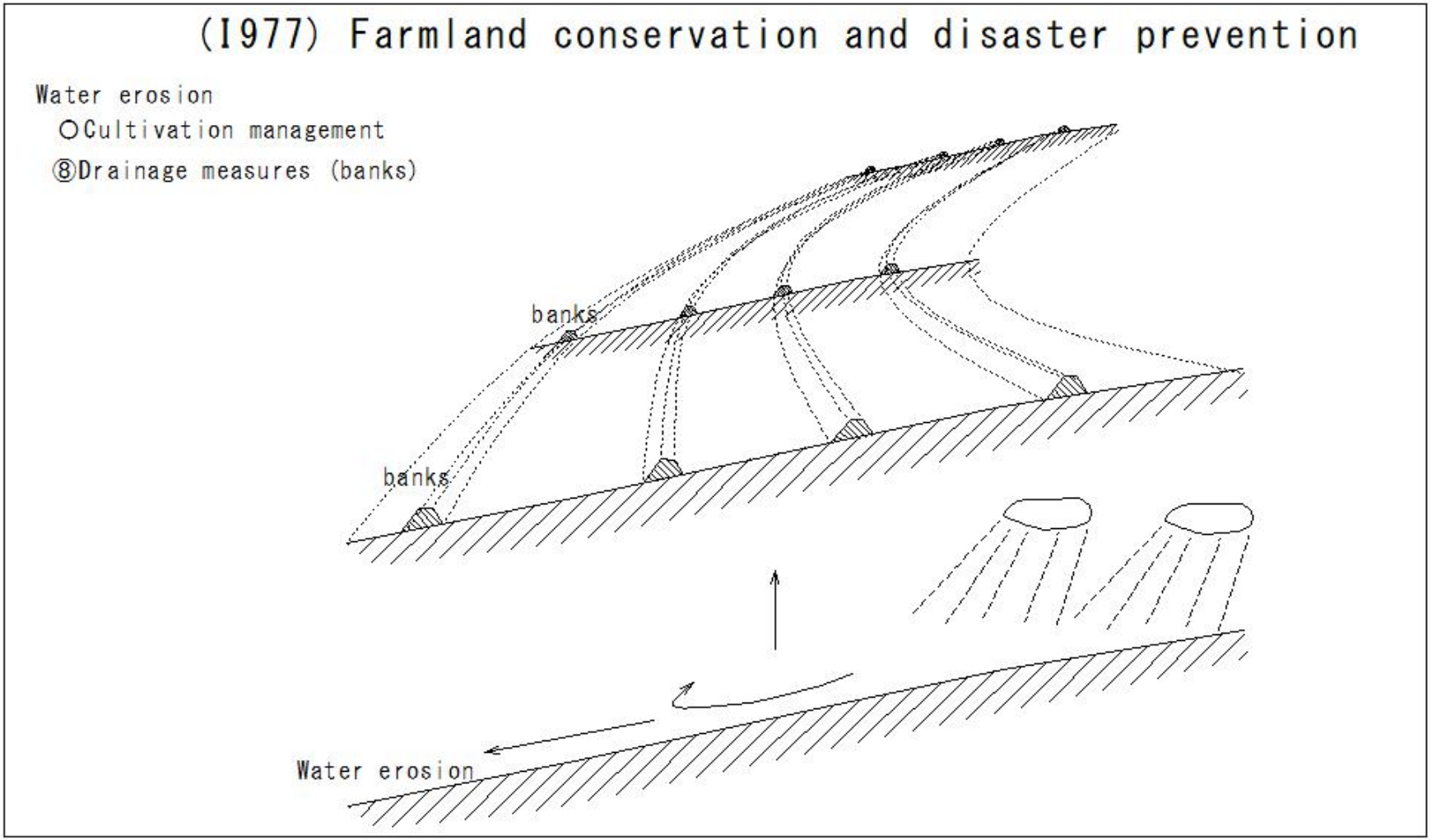
(I975) Farmland conservation and disaster prevention



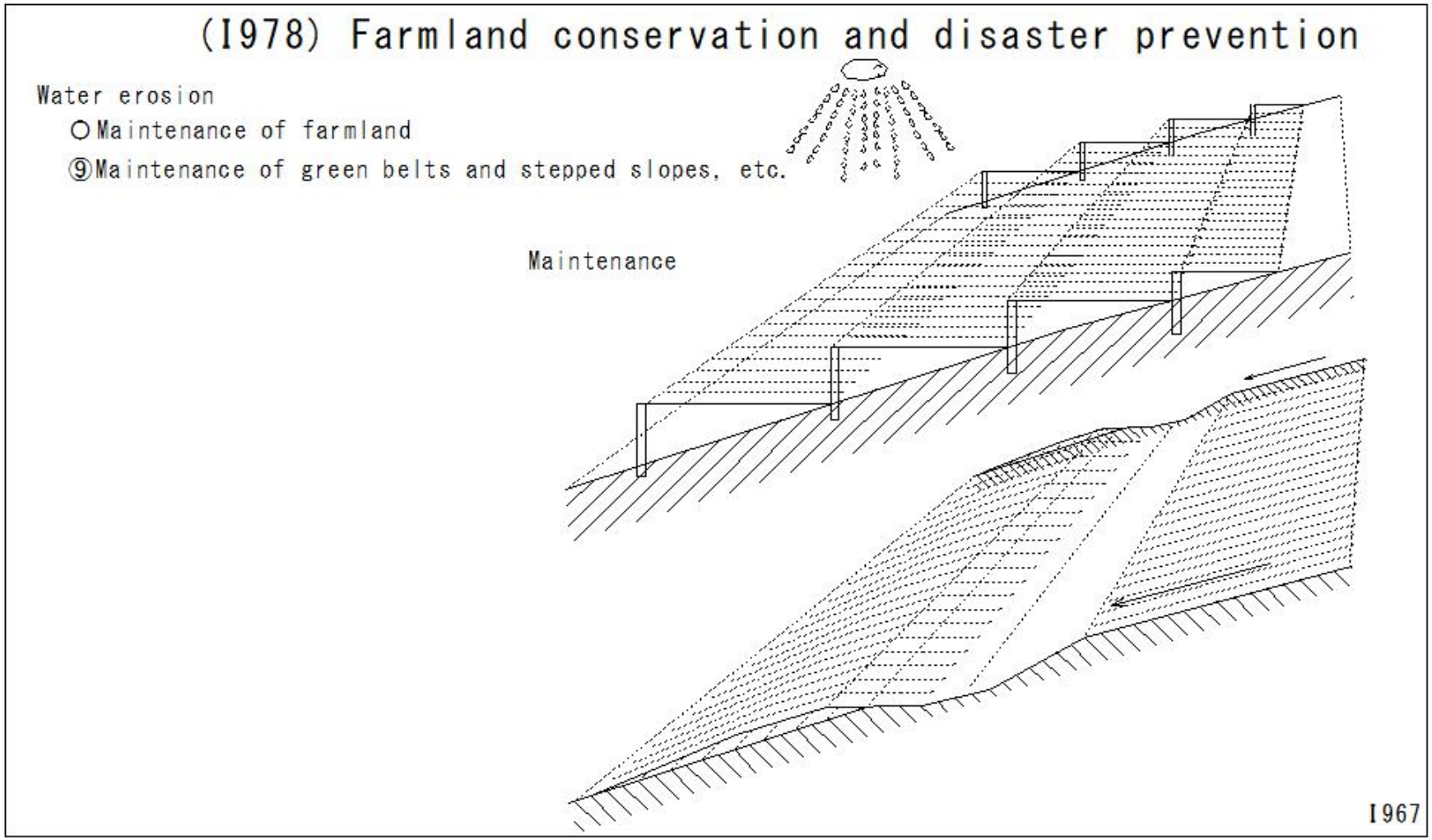
(I976) Farmland conservation and disaster prevention



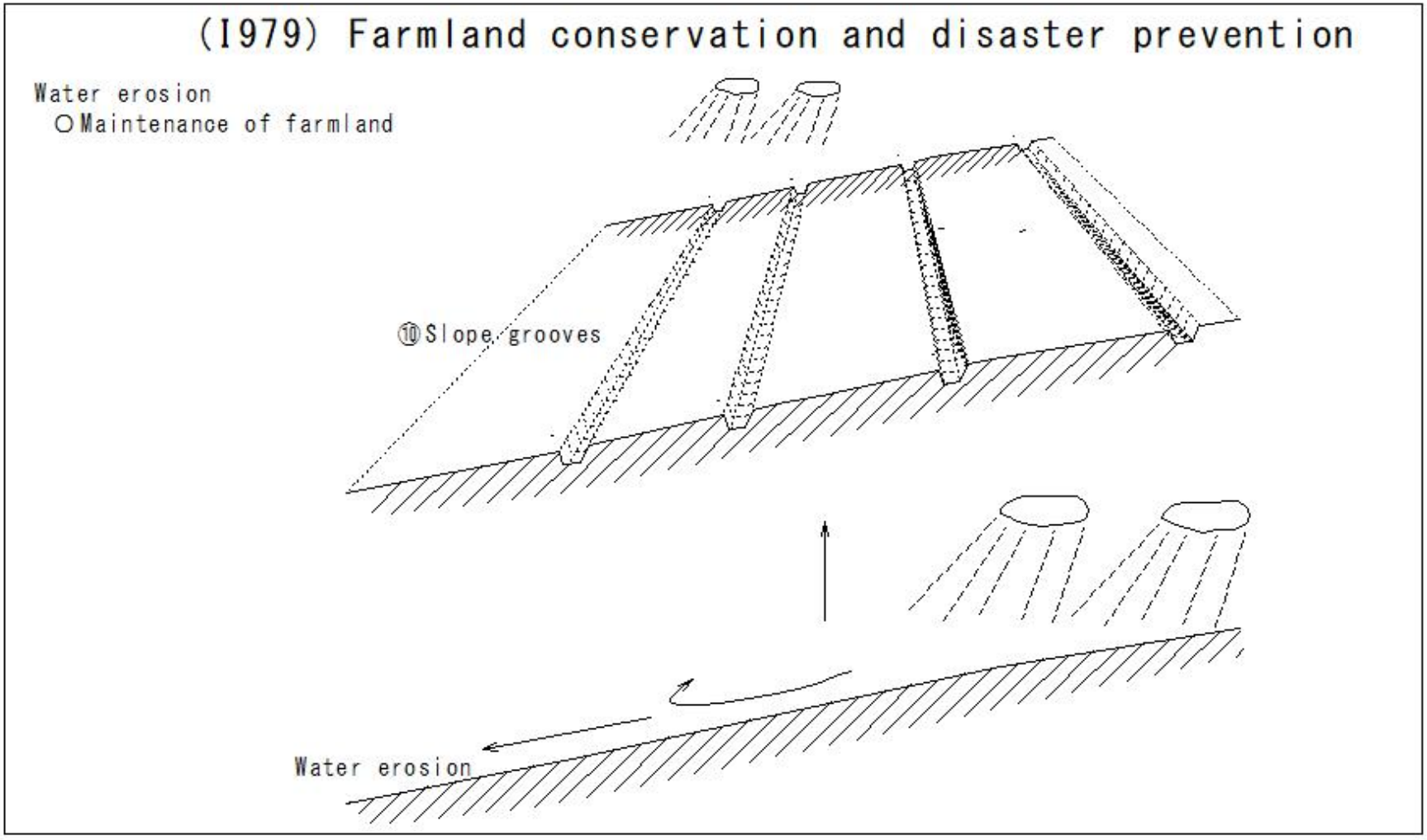
(I977) Farmland conservation and disaster prevention



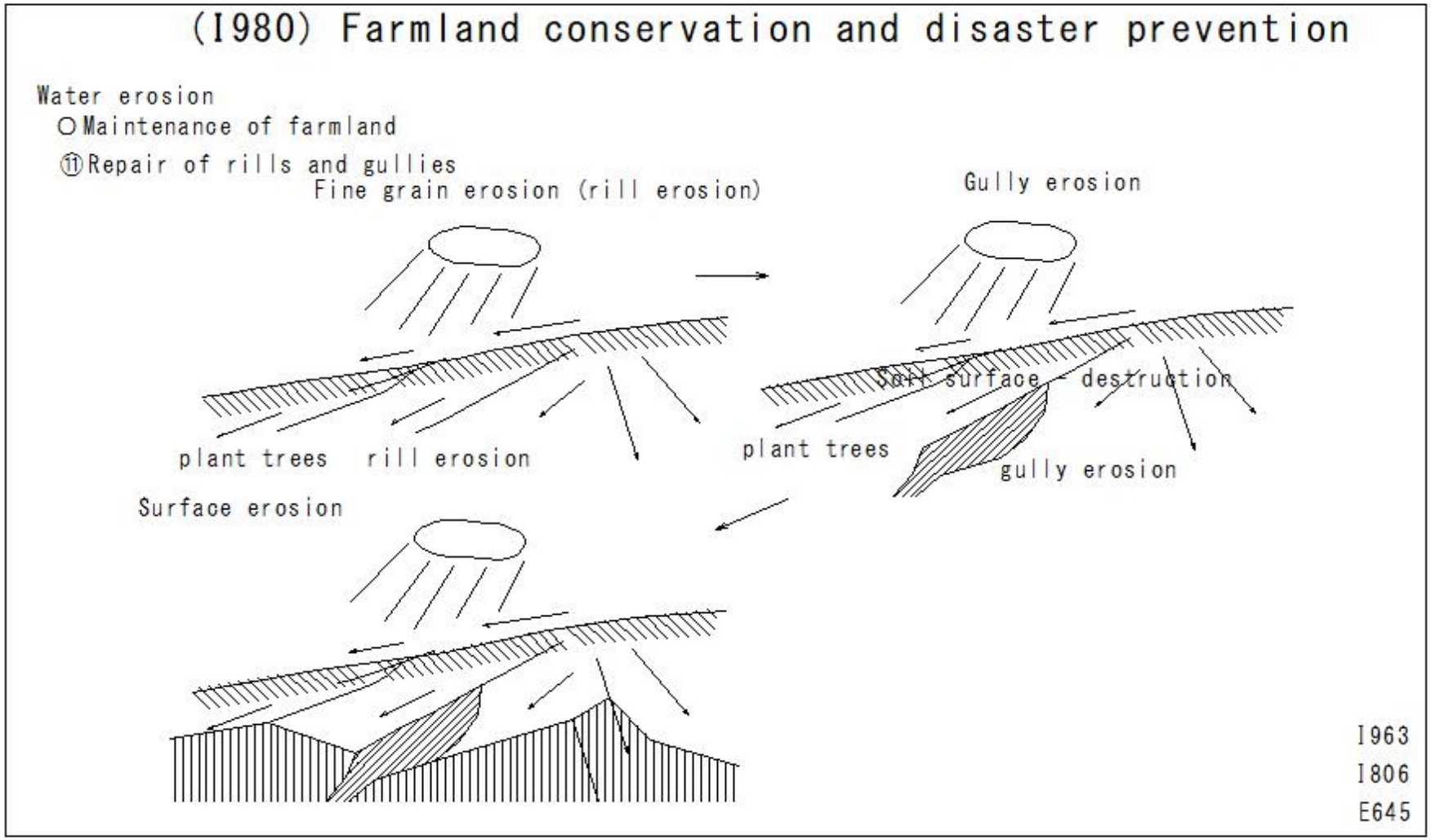
(I978) Farmland conservation and disaster prevention



(I979) Farmland conservation and disaster prevention



(I980) Farmland conservation and disaster prevention



(I981) Farmland conservation and disaster prevention

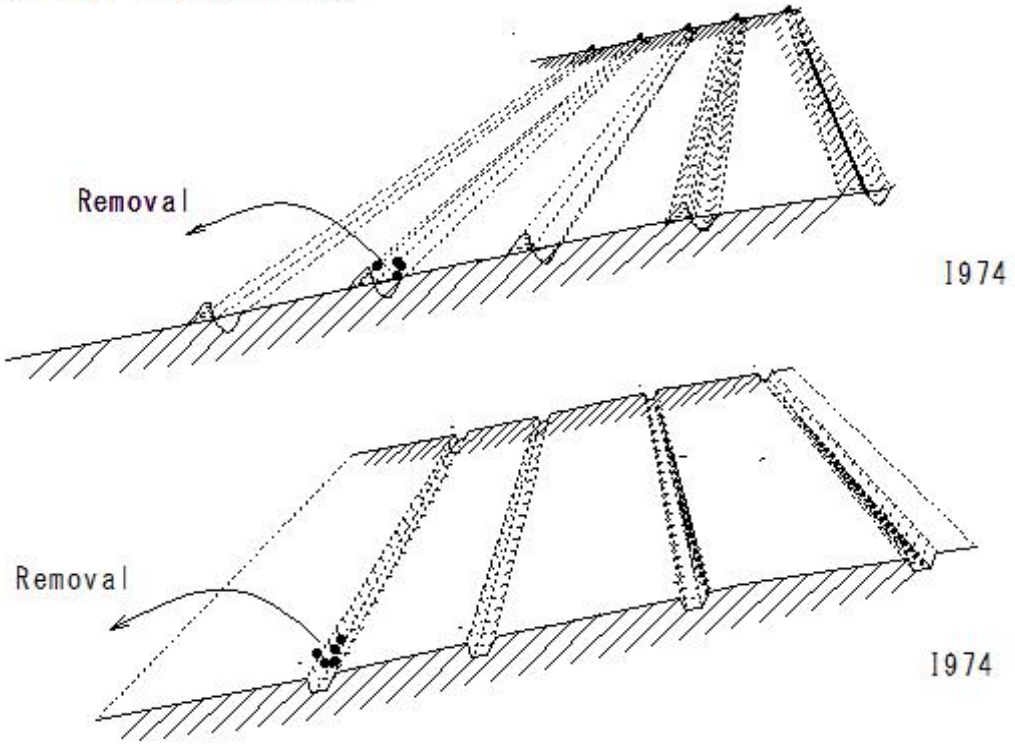
(I981) Farmland conservation and disaster prevention

Water erosion

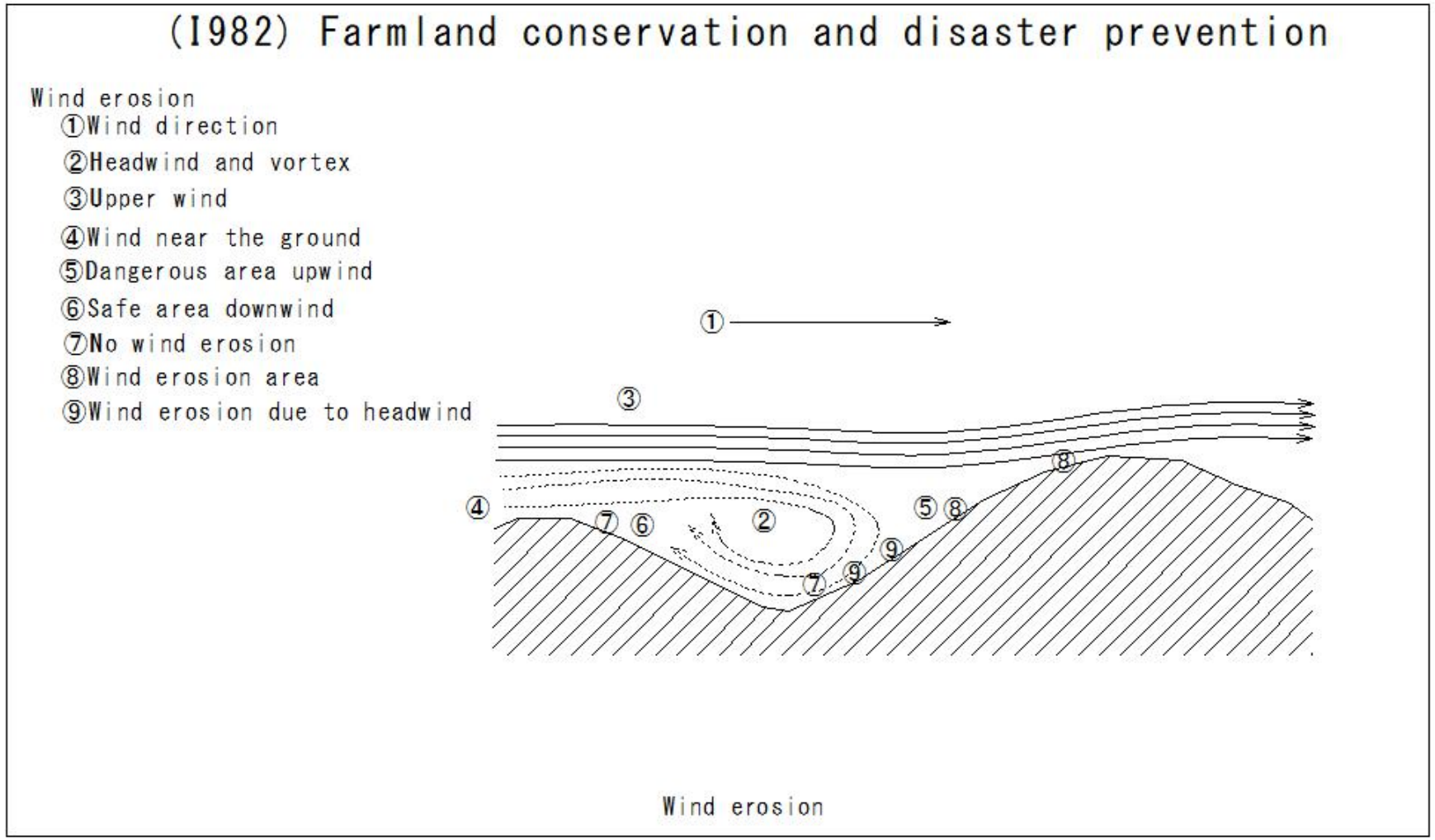
○Maintenance of farmland

⑫Removal of debris from drainage channels, collection channels, and receiving channels

⑬Removal of mud from soil and sand pits



(I982) Farmland conservation and disaster prevention



(I983) Farmland conservation and disaster prevention