

# Germany, Federal Republic of

## 1. Physiography

The Federal Republic of Germany lying in Central Europe has its borders with the Netherlands, Belgium, Luxemburg, France, Switzerland, Austria, Czech Republic, Poland and Denmark. The total area of Germany is 356,970 km<sup>2</sup> of which 7,940 km<sup>2</sup> (i. e. 2.2 %) are inland waters. The total agricultural land is 54.1 % or 19,314,000 ha which roughly can be subdivided in

- arable land (11,832,000 ha),
- grassland (5,268,000 ha),
- vineyards, orchards and nursery plants (210,000 ha),
- fens, heather, gardens (2,004,000 ha).

The total cultivated agricultural land is 17,310,000 ha in so far (1997).

In addition to this, forests occupy 29.4 % or 10,491,000 ha of the German territory without any deforestation tendency.

Topographically Germany may be roughly divided into three basic forms: the North, German Plain, the uplands and the Alpine region.

The North German Plain consists of hilly geest and moraine landscapes with many lakes as well as lowlands and glacial meltwater channels. Areas of moorland and heath are especially found in the northwest.

The hills of the central uplands separate North Germany from South Germany. The uplands are morphologically subdivided into mountainous regions and valleys, the mountains reach altitudes from 700 to 1,500 m.

The Alpine region is subdivided into the South German Alpine Foreland and the Bavarian High Alps in the south with the highest German mountain, the *Zugspitze*, reaching a height of 2,962 m above msl. More than half of the total area of Germany is hilly or mountainous. These unfavourable natural conditions narrowly limit the way the land is used and the state of farming is practised.

## 2. Climate and Rainfall

The Federal Republic has a temperate and for the most part oceanic climate, which, because of the Gulf stream, is generally much more pleasant than might be expected from its altitude. Except for peaks, the January temperatures average around freezing point, being slightly higher in the north-west and the upper Rhine valley, and slightly lower in the East and on the southern plateau. The July temperatures average nearly 18° C, with the warmest area in the upper Rhine basin.

The total average annual rainfall is 770 mm with extremes as low as 500 mm and as high as 2.000 mm. Considerabel snow falls in winter, remaining on the ground for only a short time in the west, but sometimes lasting several weeks in the east. The possible frost period lasts from 60 days a year in the West to 170 days in the East and South. In general, the precipitation amount decreases from West to East.

The climatic and rainfall conditions of the country show that drainage regulating the soil water balance is much more important than irrigation. Irrigation is mainly practised to meet short drought periods during the plant growth and to protect crops and plants from frost damage.

### 3. Population and Size of Holdings

The total population of Germany was 82,061,000 in 1997. Every 100 ha of agriculturally used land has to support about 474 people in the country, compared to approximately 381 in Italy, and about 193 in France. The total population engaged in agriculture fell from 7,040,000 persons in 1950 in Western Germany to 1,026,000 in 1997 in the reunited Germany (1.5 % of the total population).

The agricultural sector receives only 0.9 % of the national net value added, and although the share is reduced by increasing industrialization, its importance remains as great as ever in the rural areas because of other reasons too (para 6).

The total number of farms in Germany operated as fulltime and parttime enterprises has dropped by about 1 million in 1949 to approximately 516,000 farms with more than 1 ha each. In addition there are 27,500 farms below this level. 41 % of all farms are run as fulltime enterprises only. The mean size of these holdings is 41 ha in the former Federal Republic and 127 ha in the new Federal States ("Länder") respectively. For the future it can be assumed that the number of agricultural enterprises will further decline and the single farm-size grow.

In the southern part of Germany mainly small farms exist with an average acreage of 18 ha (e. g. Bavaria), where especially in the new eastern Federal States such as Sachsen-Anhalt the mean farm-size is 322 ha.

On the one hand there are fragmented farms with tiny field-plots which are most evident in the southern and south-western part of the country, where, especially in the past, the parents divide their farms among their children. In these areas, more than half of all farms in the 5 to 20 ha size group, have a number of subdivisions, some as many as 20 separate fields. Most farmsteads are so parcelled that there is not even room for necessary remodelling or new buildings.

These problems make farming more difficult and increase costs so much that the farm becomes unprofitable. For this reason, the structural improvement of agriculture land is an urgent task of agricultural policy, and all measures, which contribute to such improvements of agriculture, are given considerable financial support by the Federal and State Governments. These improvements include the consolidation of small parcels of land, improvement in soil structure and the "water economy" of the soil, road construction, re-location of homesteads to open up present crowded rural villages together with remodelling of existing farm buildings and adding of land when farms are too small.

Land consolidation describes the process that promises improvement in the structure of agriculture. In many cases, a speeding up of land consolidation and voluntary exchange of lands achieve this end. Important for the success of any of these measures is the desire for self-help on the part of the participating farmers. The State is ready to help those who want to help themselves with structural improvements which assure a higher income.

Between 1945 and 1997 land consolidation measures were accomplished in an area of 7.77 million ha. The number of measures and the affected area will decline in future.

On the other hand there is still a need in the new Federal States to cut down and privatize, among others, the about 5,500 large state farms under the communist system to economically operating private enterprises. From 1991 to 1997 the number of farm holdings in the East has risen from about 18,000 to 31,000 enterprises running now a private business. But so far farm enterprises with a size of 5,000 ha are not unusual and may be run more profitable than other forms of holdings.

Modern farm management makes heavy demands on knowledge and understanding and, therefore, upon the level of education of the farmers and those who work with them. The self-taught farmers are increasingly being replaced by the technicians schooled in a variety of farming skills.

#### **4. Land resources**

The soils that predominate in the Federal Republic of Germany are light sandy, shallow and stony, or moorland and peat soils of moderate or limited productivity. The largest areas of soils of sandy origin are found in the river lowlands of the north-western and in the southern regions of coloured sands and marl. In the mountains where soils are mostly deficient in lime and fertility, farming is made difficult by erosion and poor water holding capacity of the land. This has resulted in large acreages converted to forests and grassland uses. In the less productive soils, less demanding crops, such as rye and oats, are grown.

#### **5. Water resources**

##### **5.1 Surface waters**

The surface waters in Germany are created by six river systems, i. e. the rivers Rhine, Ems, Weser und Elb draining into the North Sea, the Odra draining into the Baltic Sea and the Danube discharging into the Black Sea. The rivers are interconnected by various canals for navigation. All rivers carry water throughout the year with varying discharges in dependence on precipitation, season and groundwater level.

Natural lakes are mainly found in the North German Plain and in the Alpine Foreland. They cover a total area of 1,213 km<sup>2</sup>. 26 of the natural lakes produce a surface area of 10 km<sup>2</sup> each. The largest lake is the *Bodensee* (Lake Constance). Additionally, there are numerous artificial reservoirs in Germany with a total capacity of more than 4 billion m<sup>3</sup> of water.

In Germany monitoring of water resources is undertaken to secure existing and possible future drinking water supplies and to protect aquatic ecosystems. Although, both biological and chemical monitoring is undertaken to provide an indication of overall water quality. For the time being the water classification is based mainly on a saprobic (biological) index system.

Monitoring for the purpose of national classification is carried out by the Länder at 146 sites throughout Germany.

The long-term objective in Germany is to ensure that all waters attain at least Class II status "moderate pollution". To a large extent this has been achieved in the western part of the country, however, in the East there are still lots of problems in particular due to the inadequate treatment of sewage, a legacy of the previous regime.

##### **5.2 Groundwater**

The groundwater has important ecological functions. Its natural quality must be preserved and protected throughout the country. The goals of groundwater quality must be oriented on the natural groundwater quality. Groundwater pollution must be eliminated.

Groundwater pollution means a long-term damage, which, if at all, can be eliminated only over long periods of time and with considerable technical and financial efforts. For this reason, the groundwater must be protected against harmful inputs of substances by means of preventive measures. To achieve this goal, also the soil must sufficiently be protected with the objective of minimizing the input of problematic substances in terms of quantity and quality from industry, trade, transport, agriculture and households.

The quality of groundwater resources is also monitored in Germany. There is significant concern in the country about deterioration of groundwater resources, not least because of their importance as a source of drinking water supplies.

The annual volume of water used in Germany (data of 1995) came to 45.2 billion m<sup>3</sup>, the greatest share of which (approx. 27.8 billion m<sup>3</sup>) was used as cooling water by thermal power stations supplying the public. The industrial sector consumed roughly 10 billion m<sup>3</sup>, and approx. 5.8 billion m<sup>3</sup> was used for public water

supplies. Mainly groundwater and spring water (72.7 %) is used for public water supplies, followed by surface water (22 %) and bank-filtered water (5.3 %). Roughly 1.0 billion m<sup>3</sup> per year is used by the agricultural sector for irrigation, livestock and greenhouses. In total, there are 161 billion m<sup>3</sup> p. a. available on average. Nevertheless, in southwest and central eastern parts of Germany, long distance water transfer networks are required to supply population centres in these areas.

Germany has succeeded since the 1970s to uncouple water consumption from general economic development. Between 1970 and 1990 water taken by industry from public supplies decreased by about one third. The water productivity of the economy as a whole has thus increased. This is also true for the per capita consumption of households, small businesses and in the agricultural sector.

Two components can be discerned: First, the prevention of pollution by way of advanced water treatment, and second the multiple use and reuse of (protected or treated) water within industrial plants. The "minimisation approach" trend will continue to be promoted as shown by the laws already in force and by current policy initiatives. In addition, there is an identifiable shift in industrial water use from groundwater to surface water.

A further trend concerns the sealing of the ground which reduces groundwater recharge and increases the risk of flooding. Increasingly, municipalities are beginning to finance the treatment of rainwater run-off through a charge based on the area of sealed surfaces. This creates an incentive to cover suitable surfaces with porous stones or to infiltrate the flow from sealed surfaces rather than feed it into sewers.

## **6. Agricultural Goals in Irrigation**

The overall task of German agricultural activities today is :

- sufficient food production at reasonable prices,
- public supply with excellent food quality for the consumer's health,
- but also safeguarding a sustainable and resilient environment (soil, water,air), preservation of cultural landscapes and tradition.

The objective of agricultural irrigation in the humid climate sector, to which Germany belongs, is to compensate individual cases of precipitation deficits during the vegetation period with artificial water supplies in order not only to improve but also to save crop and crop quality. In Germany mainly irrigation is applied to areas of intensive agricultural and horticultural activities with annual precipitation rates of less than 700 mm. It is estimated that about 531,000 hectares of land, (3 % of the agricultural acreage) today are irrigated. The irrigation methods employed are mainly sprinkler systems, for which generally groundwater is extracted. The annual amount of irrigation water used, varies between 80 and 150 mm or between 425 and 800 million m<sup>3</sup> per year respectively.

In future, after a reduction of more than 330,000 ha of irrigated area in the new Federal States because of inefficiency, irrigation will not steadily increase very much again. Sprinkler or other water saving systems will mainly be applied to special crops, vegetables and potatoes, because it guarantees high irrigation economy.

Agricultural waste water disposal which also takes place in some areas in Germany is subject to following conditions: (1) acceptance throughout the year, (2) voluntary participation by farmers, (3) possibility of distributing waste water over large areas, (4) soils are in need of irrigation, (5) suitability of crops (fruit, asparagus and vegetables are excluded). Flat ground and permeable soils are especially suited for waste water disposal.

The so-called anti-freeze irrigation works, sprinkler irrigation in addition to ground-heating, have successfully been practised in the Federal Republic of Germany in recent years to protect high value and frost-susceptible crops from frosts. On freezing nights, sprinkler irrigation is applied at temperatures below 0° C, making it possible for leaves and blossoms to be protected by the solidification heat released by the congealing water. In the Federal Republic of Germany, it is assumed that there are three freezing nights

within the frost period occurring at the end of April/beginning of May, necessitating 10 hours of overhead irrigation. Water reserves have to be calculated accordingly. Irrigation intensity (density of sprinkler precipitation) depends upon the air temperature and air movement. 2.5 mm/hour is at present generally regarded as the required minimum; if there are low temperatures and wind, proportionally higher amounts of irrigation are applied. Anti-freezing irrigation is commonly used in the Federal Republic of Germany primarily for potatoes, fruit, vine and special crops (strawberries).

## 7. Drainage

Most countries regularly implement measures to maintain soil fertility and to increase yield capacity. In humid climates, these measures consists of the removal of excess water through ditches and subsurface drainage (by pipes). The area requiring surface drainage and subsurface drainage was determined according to soil science criteria and amounts to 4.4 million ha in the old Federal States. Experience suggests that more than two-thirds of this area requires drainage (2.6 million ha of the cultivated agricultural area in the old Federal States). About 1.6 million ha of this area is drained by subsurface drainage. In the new Federal States 2.3 million ha are drained and 1.1 million ha from this area is drained by subsurface drainage.

Public subsidies, to support drainage measures, have been stopped in 1989 in the old Federal States, so clear statistics of the total drained area are not available any longer. It is estimated that private drainage measures are performed to an amount of about 5,000 ha per year, so, because of the limited lifetime of drainage systems, the total amount decreases. Another reason for the decrease is the use of this area as natural resource area or as flood retention area in more and more cases.

## 8. Statistics Relating to Irrigation and Drainage

Area cultivated in 1950	14,126,000 ha	} old Federal States
Area cultivated in 1970	13,578,000 ha	
Area cultivated in 1978	13,176,000 ha	} old and new Federal States
Area cultivated in 1997	17,310,000 ha	
Area irrigated in 1949	220,000 ha	} old Federal States
Area irrigated in 1959	250,000 ha	
Area irrigated in 1976	253,000 ha	
Area irrigated in 1979	270,000 ha	
Area irrigated in 1989	320,000 ha	} old and new Federal States
Area irrigated in 1997	531,000 ha	

Capital costs per ha irrigated sprinkler irrigation, dependant on real conditions, vary from 1.500,-- to 10.000,-- DM.

Operation and maintenance costs per ha irrigated sprinkler irrigation are about 5,-- DM/mm.

Area drained in 1966	2,600,000 ha	old Federal States
Area drained in 1997	4,940,000 ha	old and new Federal States

The drainage costs are dependant on local conditions and vary as follows:

Measure	Costs (DM/ha)
1. Drainage by ditches	800 – 3,000
2. Pipe drainage	1,500 – 8,000
3. Combined drainage (1.+2.)	3,000 – 6,000
4. Mole drainage	300 – 700

## **9. Outlook**

One characteristic of water management in Germany is the clear separation between state institutions with global responsibility for water resources protection and management on the one hand, and on the other hand private or municipal operators carrying out specific functions of relevance to water management. The state administration, as a rule, has no direct interest in water use or the use of water bodies so that in principle conflicts with private interests do not occur. Any significant use of a water body has to be permitted by the competent supervisory authority and no special rights or privileges result from private ownership of watercourses which, in any case, exists only for minor watercourses.

The implementation of environmental policy through direct regulation by prescriptions, prohibitions and limit values has, in water resources protection and management, been combined with economic instruments, both for setting incentives and providing revenue.

Germany does not suffer from water scarcity, however, water saving measures are taken in all producing sectors. The agricultural sector too needs water of good quality for saving crops of good quality and improving productivity and it needs land improvement for this purpose including rural development for other income possibilities.