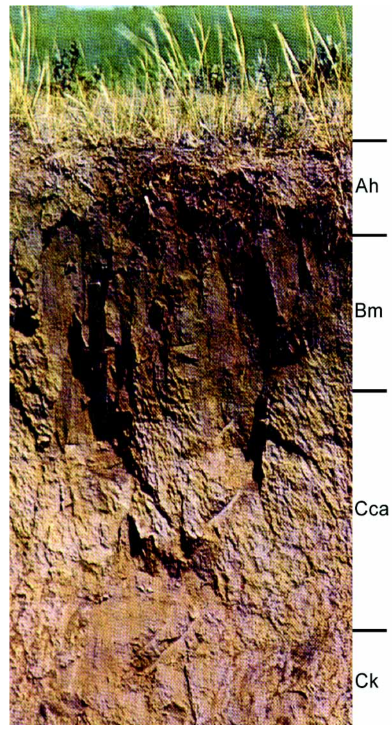
5.2.3 The Chernozemic Order

Description:
Soils classified within the Chernozemic order in the Canadian System of Soil Classification are well to imperfectly drained mineral soils of good structure. They have dark-colored virgin or cultivated A horizons, which are very dark grayish brown to black when moist. The underlying B or C horizons have high base saturation and accumulations of lime carbonate usually occur in the lower part of the solum. These soils have developed within areas of cool boreal to cold cryoboreal, subhumid to subarid continental climates and are found in the Canadian prairies and the rangelands of interior British Columbia (Clayton et al., 1977).



Diagnostic Horizon: Chernozemic soils must have the chernozemic Ah diagnostic horizon which must be at least 10 cm in thickness, have a color value < 3.5 moist or 5.5 dry and chroma < 3.5 moist, contain 1 to 17% organic carbon, have a base saturation > 80% with Ca^{+2} as the dominant cation and have a mean annual soil temperature > 0°C and a moisture regime drier than humid.

Genesis: Humus-enriched A horizons develop by the accumulation and decomposition of a cyclic growth of xerophytic to mesophytic grasses and forbs typical of grassland or transitional grassland-forest communities. In these soils, the rate of addition is greater than decomposition, therefore humus (decomposed and resistant organic matter) accumulates in the surface horizons.

Great groups: Chernozemic soils are further divided into four major divisions, the Brown, Dark Brown, Black and Dark Gray Chernozemic great groups. They are distinguished by measurable differences in the color of the A horizons, which together with other associated features of depth, organic matter content, and structure, reflect significant differences in the ecological environment of soil climates and vegetation under which they have developed, and which continue to influence and distinguish their characteristics and relative use capabilities (Clayton et al., 1997).

Common horizon sequences: **Brown Chernozems** soils occur in the most arid segment of the climate range of Chernozemic soils and have brownish-colored A horizons. They are associated with xerophytic and mesophytic grass and forb vegetation. Brown Chernozems have chernozemic Ah or Ap horizons with color values darker than 3.5 moist and 4.5-5.5 dry. The chroma of the A horizon is usually higher than 1.5. The soil climate of this great group is typically cold, rarely mild, and is subarid to semiarid. A common horizon sequence for the Orthic Brown Chernozem is Ah, Bm, Cca or Ck. The underlined horizons must be present.

Dark Brown Chernozems have A horizons somewhat darker in color than soils of the Brown Chernozem great group. Dark Brown Chernozems usually occur in association with a native vegetation of mesophytic grasses and forbs in a semiarid climate. Dark Brown Chernozems have chernozemic Ah or Ap horizons, with color values darker than 3.5 moist and 3.5-4.5 dry. The chroma of the A horizon is usually higher than 1.5. The soil climate of this great group is typically cold, rarely mild, and semiarid. A common horizon sequence for the Orthic Dark Brown Chernozem is Ah, Bm, Cca or Ck. The underlined horizons must be present.

Black Chernozems have A horizons darker in color and commonly thicker than soils of the Brown Chernozem and Dark Brown Chernozem great groups. Black Chernozems usually occur in association with a native vegetation of mesophytic grasses and forbs or with mixed grass, forb, and tree cover. Black Chernozems have chernozemic Ah or Ap horizons with color values darker than 3.5, moist and dry. The chroma of the A horizon is usually 1.5 or less, dry. The soil climate of this great group is typically cold, rarely mild, and is subhumid. A common horizon sequence for the Orthic Black Chernozem is Ah, Bm, Cca or Ck. The underlined horizons must be present.

Dark Gray Chernozems have A horizons with characteristics indicative of eluviation associated with soils developed under forest vegetation. Dark Gray Chernozems usually occur under mixed native vegetation of trees, shrubs, forbs, and grasses in forest-grassland transition zones in areas of cold, subhumid soil climate. Virgin Dark Gray Chernozems usually have leaf mats (L, F, and H horizons) overlying Ah or Ahe horizons. Dark Gray Chernozems have chernozemic Ah or Ap horizons with color values darker than 3.5 moist and 3.5-4.5 dry for virgin soils (3.5-5 dry for Ap). The chroma of the A horizon is usually 1.5 or less, dry. Dark Gray Chernozems may have a light-colored Ae horizon 5 cm or less thick, provided that the mixed surface horizon (Ap) meets the requirements specified for the great group. Similar soils having a distinct Ae horizon thicker than 5 cm below the chernozemic A horizon and a Bt horizon are classified as Dark Gray Luvisols. The soil climate of this great group is typically cold and subhumid. A common horizon sequence for the Orthic Dark Gray Chernozemic soils have Ahe, Ae, Bm or Btj or Bt, Cca or Ck. The underlined horizons must be present.

Extent and Use: Chernozemic soils are found as dominant components of map units comprising about 468, 112 km^2 or roughly 5% of the land area of Canada. An additional 15, 459 km^2 are estimated to occur as subdominant components of other map units. These soils are extensively used for agricultural activities ranging from field cropping to livestock economy and have influenced the pattern of human settlement in the Canadian prairies.

Applications

Cultivated agriculture began in the Canadian Prairies at the turn of the twentieth century. There was scarce information on how to farm the dry and irrigated lands of the Prairies and the forested lands farther north. Experiments were started by the Dominion Department of Agriculture to develop crop rotations, conserve soil and water , and address issues being faced by producers. The locations of research stations currently being operated by Agriculture and Agri-Food Canada in major zones of the Prairie region are shown in Fig. 5.3. In addition to these, there are many medium and long-term crop rotation experiments in the Prairies which are being managed by private sector, university and provincial government organizations.

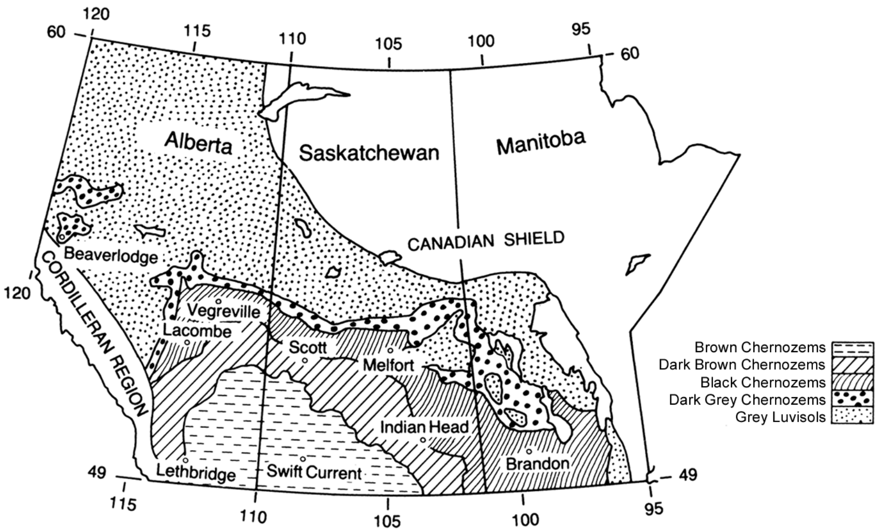


Fig 5.3. Locations of research stations operated by Agriculture and Agri-Food Canada in major soil zones of the prairie zones (Campbell et al., 1990). Reproduced with permission from Agriculture and Agri-Food Canada and the Minister of Public Works and Government Services Canada, Ottawa.

The crop rotation studies were set up at different locations to understand the impact of climatic and soil factors on crop rotations in terms of agricultural, environmental and socio-economic sustainability. Arable soils of the Prairie provinces range from: Brown to Dark Brown Chernozems in Southern Saskatchewan and Alberta; to Black Chernozems in Manitoba, Saskatchewan and Alberta; Dark Gray Chernozems in the northern part of the central prairies; and Gray Luvisolic soils in the north (Fig. 5.3) (Campbell et al., 1990). These studies show that: (1) regardless of the cropping systems, periodic rotations are recommended for the control of certain weeds, diseases and insects; (2) crop production and soil physical structure are improved with crop rotations; (3) crop rotations affect the amount of organic matter stored in the soil; and (4) nutrients which are removed from the soil with the harvested product or lost from the soil through leaching or denitrification must be replenished in accordance to crop needs. These studies are also leading to the development of knowledge-based agricultural systems.

The data from selected treatments of the long-term rotations in Southern Alberta (Janzen et al., 1997) and the Semi-arid Northern Great Plains of Canada (Campbell et al., 1997) are a part of the North American Great Plains Network and are also archived on GCTE SOMNET (The official GCTE Soil Organic Matter Network Database) website (http://saffron.res.bbsrc.ac.uk/cgi-bin/somnet-expts) in Rothamsted, United Kingdom. These datasets are being used to develop simulation models of soil organic matter dynamics in different agroecosystems around the world.