SUMMARY OF PREVIOUS WORK
CHAPTER-II

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In the arid and semi-arid areas, majority of the soils are immature, structureless and very coarse in texture with low water holding capacity, poor nutrient status and with low productive potential. The soils become unfit for growth of plants because of the presence of salts or excessive sodium in exchange complex. Such problems associated with arid and semi-arid areas have been addressed by various workers in their investigations on various aspects of the soil. Some significant contributions in each field are listed in this chapter.

Dokuchaev (1879) made a first approach of classification which is known as Genetic soil classification”. This system of classification was based on interaction of five major soil-forming factors. Sibirtzev (1895) classified the soils into three main classes viz. Zonal, interzonal and a zonal soils. Raman (1911) classified the soil of Europe based on the influence of climate and vegetation. Coffey (1912) classified the soil on the basis of their own properties and proposed five major classes i.e. arid soils, dark coloured prairie soils, light coloured timbered soils, black swamp soil and organic soils. Marbut (1935) classified the soils in USA on the basis of nature of parent material, soil morphology and chemical composition of soils, iron-alumina and lime content. Simth (1968), Walton (1969) carried out the classification of the soil in arid region.
To overcome the shortcoming of the genetic systems USDA soil survey staff (1960) published “7th Approximation” system of soil classification and this system was brought out as soil Taxonomy (1975) with precise and quantitative definitions of ten soil orders. Later on, two more soil orders Andisols and Gellisols were included in soil Taxonomy (1998). This system is being adopted in USA, India, Iran and many other countries. This system is being preferred over the other old systems due to its many advantages and the definitions are precise and quantitative rather than comparative. For saline alkali soils Sehgal et al. (1975) proposed salic subgroup with natrustalfs to classify salorthids with lithogical discontinuities and irregular distribution of organic carbon with depth. Sawhney et al. (1992) reported that the young and stratified soils from unstable landforms were classified as Typic Ustipsamments, foothills were classified as Typic Ustrothent, and the soils developed on relatively stable landforms show development of combic horizon and were classified as ustochreptic comborthids. Similar findings were also reported by Sehgal et al. (1987).

Numerous summaries of information on salt affected soils are available. Carter (1962) published a bibliography of works done on saline and sodic soils. Some important works include that of Kelley (1951), Richards (1954), Bernstein and Hayward (1958), Strongonov (1964) and Allison (1964). Bresler and Carter (1982) pointed that the main source of salt in soil of arid and semi-arid regions is dry climate, weathering of minerals and hydrological, hydrogeological and human activity. The problems associated with degradation of semi arid soils have been recently studied world over by a number of workers. Robert et al. (1996) carried out simulating vegetational and hydrological responses to

The morphological, physical and chemical properties of the soils of arid and semi-arid regions in various parts of the globe have been studied in recent years by a number of workers. Jenny (1941) reported that in the region having 380 to 890 mm rainfall, the pH decreases with increasing rainfall whereas, N, clay content and depth of CO3 in soil increases. Mohamed and Gohar (1960) assigned a negligible role to silt and sand to contribute to cation exchange capacity in addition to clay and organic matter. Boul (1964) Bilzi and Ciolkosz (1977) stressed the relationship of soil characteristics with time. Hedge et al. (1978) and Grieve (1980) observed significant difference in bulk density, organic carbon and total nitrogen in both the surface and subsurface layer of soils developed under different vegetation. Daniels et al. (1983) described change in morphology of a mature profile with major variation in vegetation. Singh (1984) reported that the desert soils are alkaline in reaction and low in soluble salts. He further observed that these soils are calcareous in nature and usually have low organic carbon content. Similar observations were also reported by Sehgal (1986). Nel (1985) reported that the compaction of top soil
layer can modify soil properties such as permeability, resistance to root penetration, aeration and water holding capacity. The feasibility of predicting these properties from particle size distribution parameters of sandy soil was also investigated by him with the exception of permeability, which decreased with decrease in size of particles. No significant correlation was found between particle size distribution and physical properties of sand samples. It was concluded that either the selected particle size distribution parameters are not suitable for predicting the effect of compaction or the particle size distribution as such cannot be correlated with the physical properties of compacted sands. Goyal and Singh (1987) reported that in dunal area, sandy texture, low organic carbon and low moisture regimes may be responsible for the relatively low status of available nitrogen. They reported, while studying the distribution of available nitrogen indifferent land forms of the semi-arid region of a part of South Haryana, that the low lands and basin with high contents of clay and organic carbon were high in, available nitrogen (up to 208 kg ha$^{-1}$) in the active fluvial plains of Sahibi river flood plain. In all the cases nitrogen content decreased with depth in the soil profiles. Choudhari (1989) stated that water-holding capacity has significant positive correlation with silt, clay and ESP and significant negative correlation with coarse sand. Similar observations were also reported by choudhari and Dhir (1982), Kutilek and Semotan (1975) and Thomas and moody (1962). Singh et al (1989) stated that the saturated hydraulic conductivity was better correlated with sand and silt content of the soil than clay content. Malik et al. (1990) stated that, in semi-arid regions, soil are generally coarse textured inherently low in their fertility and organic matter
content and have calcium carbonate concretion layers. Thomas and Pamola (1990) studied the relationship between the strength and moisture content at saturation with or without the presence of calcium carbonate in the soil samples. In most cases, strength declined with increasing moisture content. Dutta and Joshi (1990) stated that different dunal and interdunal soils are alkaline in reaction (pH 8.3 to 8.9), low in their salt, organic carbon content and CEC. Manrique and Jones (1991) reported decrease in bulk density with increase in the depth of the soil. They further reported that texture or other properties played more significant role in controlling bulk density, in comparison to the role played by organic carbon. Bain et al. (1993) studied the weathering process and rates with time and observed that exchangeable Ca and Mg decreased with time and the base saturation decreased from 24.6 percent in the AP horizon of the youngest profile to 2-8 percent in the comparable horizon of the 10,000 yr. old profile. Raji, Chude and Esu (1997) carried out the extractable and total Fe and Mn contents of three sand dune soils in NW Nigeria. Sen et al. (1997) studied the soils derived from sedimentary and metamorphic parent material and observed that the morphology, physical and chemical properties show variation in pedogenic development of the soil w.r.t., to their geology and physiographic position. Khresat, Rawajfih and Mohammad (1998) studied the morphological, physical and chemical properties of selected soil in the arid and semi arid region in Northwestern Jordan. Hiernaux et al. (1998) carried out the effects of livestock grazing on physical and chemical properties of sandy soils in Sahelian range lands. They found that langmuir
adsorption maxima ($b_2$) was positively correlated with clay content, CEC and P concentration and negatively correlated with CEC.

The soil formation is a process of two consecutive stages: the weathering of rock into regolith and the formation of soil from the regolith and involves several factors whose influence is reflected in different soil types. Dukuchaev (1879) founder of pedology in Russia, classified the soils based on the interaction of five principles of soil forming factors, viz, time, parent material, relief, living organisms and climate. He classified soils into normal, transitional and abnormal soils depending on the progress of pedogenic processes. The system did not cover all type of soils in the world, especially tropical soils. Hilgard (1893) reported the importance of pedogenic factors in soil formation. Marbut (1935) stressed environmental factors for soil formation. Polynov (1937) stated that the first phase of soil genesis consists of preparation and accumulation of soil material through weathering agencies. In the second phase, development of soil profile takes place. Jenny (1941) proposed the following equation for soil development and soil forming factors: $S = F (c,l,o,r,p,t)$ where: $s$=soil, $c$=climate, $o$=organism, $r$=relief, $p$=parent material and $t$=time. Jenny (1941) considered the five factors named by Dokuchaev as independent variables. Joffee (1949) observed that parent material, topography and time serve as a source of mass, whereas element of biosphere supply energy for the process of soil formation. Stephens (1950) and Karale (1962) observed that climate factors of soil formation appeared to be decisive in characterizing the soil. Gupta (1952) observed that drainage conditions are more important than the parent material and climate. Mitchell (1955) stated that parent material had
more pronounced effect on the type of soil. Mitchel (1955) and Karale et al. (1969) reported that nature of parent material had pronounced influence on soil formation and characteristics. Rode (1961) considered eight factors of soil formation, the additional three being gravity, water and man. Bidwell and Hole (1965) discussed the role of man as a factor of soil formation. Khanna et al. (1977) stated that the major soil forming factors such as climate, parent material and topography have taken active part in the formation of soil in Dadri area. They further reported that mechanical weathering with a little chemical weathering of extensive aeolian sand deposits, which constitute the parent material, has taken place. According to Prasad et al. (1977) while working in Junagarh, the influence of parent material was counteracted by the physiography of the area and bioclimatic force. Ivanov (1986) studied the effect on barchan sand dune profile of microimfaction caused by salting sand particles. The formation and stability of a barchan dune profile and comparisons with profile of other aerodynamic shape are also discussed. Eltayeab and Hassan (1988) described two approaches, which may be used in the theoretical analysis of sediment transport, and dune and ripple formation; in their study they used an approach involving the use of hydrodynamic equation and an empirical equation of sediment transport. In their study they assumed that deformation of sand bed is due to its instability. The potential flow model, which is the simplest theoretical model, was found to predict results with fair degree of accuracy. They further reported that evolution of dunes cannot be described using the linear stability theory. Eltayeab et al. (1988) stated that mechanical and chemical weathering of rocks leads to the formation of desert
sands. The major agent of erosion and dune formation is wind. Wells et al. (1990) stated that the most significant period of aeolian landform construction is inferred to have occurred during the latest pleistocene glacial to inter glacial climate change forming wide spread sand sheets and modified parabolic dunes. Kaistha and Gupta (1993) reported that low temperature during most part of the year, resulting in low microbial activity was responsible for limited profile development. Atalay (1996) studied the Palaeosols as indicators of the climatic changes during Quaternary period in S. Anatolia. Mc Tainsh et al. (1997) carried out the climatic controls upon dust storm occurrence in eastern Australia. Ramsperger and Peinemann (1998) studied the deposition rates and characteristics of aeolian dust in the semi-arid and sub-humid regions of the Argentinean Pampa.

The soils of the research area including Seistan plain (Iran) and SW Haryana (India) have been studied in their limited aspects earlier. Some important contributions including those for surrounding areas and related topics are summarized here.

Ital Consult (1962), Gib (1967), Office of Water Soil Engineering. (1972) and Soil Institute of Iran (1975) studied some physical and chemical properties of Seistan plain. Mahjoory, R.A (1975) studied the clay mineralogy, physical and chemical properties of some soils in arid regions of Iran. Soil institute of Iran (1975) reported that the soils of Seistan plain mostly fall in to alluvial soils and solonchaks, which can be correlated to Fluvisols and solonchaks of F.A.O/UNESCO and Entisols of USDA soil classifications. Fujikawa et al. (1978) studied the estimation of consumptive use of crops in the seistan
farmland development project, Iran. They concluded that the penman method was as the most suitable one to estimate the consumptive use of crops in the area. Abtahi (1980) while studying the topographic features in Iran observed that slightly Saline, coarse textured soil occurred at high elevation whereas, fine textured soils of higher salinity occurred at low elevation. Gharae and Mahjoory (1984) identified characteristics and geomorphic relationships of some representative Aridisols in southern Iran. They studied the morphology, genesis and classification of three soils, each located on different physiographic positions. Amiri-Nejad et al. (1999) stated the calcification of soils in a toposquence under semi-arid conditions of Kermanshah, Iran. Alluvial-colluvial fans, piedmont alluvial plains, and old plateaux were three main physiographies on the selected toposequence. Tomanian et al. (1999) identified geologic sources of gypsum in soils of northwest of Isfahan, Iran and further observed that gypsiferous soils, as the most characteristic soil in arid and semi-arid regions, are widespread in Isfahan province. The Northwest region of Isfahan is a closed basin and is surrounded by geologic formations. Field observations showed that in Shemshak and Nayband formations, gypsic crystals were present within the layers of weathered shales, and pyrite was observed only in the mine shales. In weathered red conglomerates (Lower cretaceous), considerable amounts of gypsum had accumulated. Hajabbasi et al. (1999) reported the tillage effects on some physical properties of soil in maize field in Lavark Research farm (South of Iran); a two-year study (1996-97) was conducted to varify tillage effects on several soil properties and corn yield. They concluded that, no till system in this region would be recommended.
Basirani and Gill (1999) presented a Panoramic glance at the Agriculture of Islamic Republic of Iran vis-à-vis soils conditions. Basirani (2000) identified the processes of desertification in Iran. He predicted some major changes in arid and semi-arid lands in future. He has suggested some remedial measure for reclaiming the arid areas. Basirani and Gill (2000a) presented a mathematical model to predict moisture characteristics of a soil from the database of some physical and chemical properties. The quantitative parameters of soil samples from Seistan and Baluchestan provinces of Southeast Iran were used. Basirani and Gill (2000b) presented a model predict the moisture characteristics of a soil from soil texture, bulk density and organic matter. They opined that field capacity (FC) and permanent wilting point (PWP) could be estimated in multiple regression models. Maftoun et al. (2000) reported characterization of Zn Adsorption in some calcareous Paddy soils from Fars province (Iran). Mosaddeghi et al. (2000) studied the compatibility of Lavark soil as affected by soil moisture content and farmyard Manure. The results from this study indicate that the manure application at a rate of 50 t ha⁻¹ reduces soil compactibility and increases soil moisture trafficability range. Hossein-pour and Kalbasi (2000) studied the potassium quantity intensity Ratio of some soils of Iran and correlations of its parameters with selected soil properties. They found that correlation coefficients between Q/I Parameters and soil properties is not very high. Noorbakhsh and Afyni (2000) studied estimating of field capacity and permanent wilting point from some soil physical and chemical properties in some soils of Iran. Their results showed that FC significantly correlated with sand, organic matter and cation exchange capacity in a stepwise model.
PWP of soil also correlated significantly with silt, organic matter and cation exchange capacity in a stepwise model. They reported that available water capacity (FC-PWP) correlated with sand in a stepwise model and they concluded that on the whole, results showed FC and PWP can be estimated from some soil physical and chemical properties. Basirani, and Gill (2001a) studied the soil degradation in south Asia taking Iran as a special reference. Basirani and Gill (2001b) presented on overall view of Agricultural development in emphasizing the climatic and physiographic effects on the production and their remedial measures. Basirani and Gill (2001c) studied the environment aspects of wetland ecosystem of Seistan Basin, S.E. Iran. They have highlighted some adverse effects of the wetlands and suggested some conservation measures. Rezaenejad and Afyuni (2001) stated the effect of organic matter on soil chemical properties and elemental up take. Their results indicated that cow manure and sewage sludge had a high fertilizer value and led to heavy metal concentrations in soil as well as corn tissues, which were much lower than the reported standards.

Raychoudhary et al. (1963) classified the calcareous soils of Punjab and Haryana as pedocalsireozems. Roonwal et al. (1967) reported the spread of sand and dust from the desert regions of Rajasthan to the adjoining areas of Punjab and Haryana. Khanna et al. (1968) placed the soils of Hisar district under the order Aridisols, Sub order orthids and great group “calciorthids” camborthids and salorthids. Mekin et al. (1969) introduced one new great group, halorthid and several new subgroups, natric crumusterts, natric crumsqerts and Typic Halorthids. According to Shankaranrayan and Hirakerur
(1972) and Sidhu et al. (1976) varying amount of rainfall was responsible for
variation in morphological and other soil characteristics in the Northern plains of
India. According to Hilwig and Karale (1973) the basic physiographic processes
induced from photo-interpretation to field work in the Ganges plain were mainly
(a) Aeolian sedimentation to a limited extent (b) erosion (c) fluvial
sedimentation and (d) tectonic movements. The occurrence of fluvial and
aeolian processes have also been reported by Roy et al. (1967),
Shankaranaryana and Hirekerul (1972) in Western Rajasthan and north Indian
plains. Sidhu et al. (1976) observed that in central Punjab surfacial deposition
of aeolian dust is responsible for relatively nigh pH, EC, ESP and time
equivalent in the surface soils. By using techniques of aerial photographs and
land sat imagery several workers have established landscape-soil relationship
in Haryana state. Bhandari et al. (1976), Manchanda (1978), Goyal et al.
(1978), Ahuja et al. (1978), Sangwan (1978), Manehanda and Khanna
(1979), Goyal (1981), Ahuja (1981) and Garalapuri et al. (1980) have
established landform-soil relationships in different soil and bioclimatic regions
of Haryana. Sangwan (1978) found better relationship between water holding
capacity and clay and calcium carbonate content of the soil. Sharma and Nath
(1979) studied the moisture retention characteristics of soils of Hisar and
observed that the moisture retained at 0.33 bar showed significant positive
correlation with clay ($r = 0.776$) silt + clay ($r = 0.904$) and silt ($r = 0.979$),
whereas the amount of water held at 15 bar showed highly positive correlation
with clay ($r = 0.962$), silt + clay ($r = 0.937$) and silt ($r=0.618$). However
significant negative correlations were observed between moisture retained at
0.33 and 15 bars and sand. The similar results were also obtained by Choudhuri (1989). Sangwan (1980) while studying the soils of Haryana reported that physiography has a bigger role over other factors in the formation of soils. Manchanda and Khanna (1981) proposed Epiphalic, Epinatric and Epiphalonatric subgroups in Saline-alkali soils of Haryana. Shanwal (1984) and Shanwal et al. (1988) grouped Yamuna alluvial plain into recent flood plain and young meander plain. He further advocated that the soils of an alluvial plain showed signs of profile developments whereas, the soils of recent flood plain were quite immature. Goyal et al. (1985) and Ahuja et al. (1997) observed significant variations in soil characteristics of soils developed on different physiographic position in the semi-arid region of Haryana. Sehgal et al. (1986) reported that to the North and East of Thar desert are mixed sand dunes, sandy plains and fine textured plains of Quaternary alluvium. It is believed that the sands with which it is covered are largely blown in from the coastal regions and the Indus Valley. Singhari (1990) studied in detail the geomorphology and soils of Haryana state for his Doctoral degree. Singh et al. (1991) characterized and classified some mid altitude soils of outer Himalayas as Alfisol, Inceptisol and Entisol. In Haryana, regional survey by Goyal et al. (1999), Kuhad and Goyal (1998), Ahuja et al. (1978), Manchanda et al. (1973), Yadav (1999) have suggested vide occurrence of Camborthids, Calciorthids, Torripsamments, Ustipsamments, Udorthents, Ustorthents, Ustrochrepts, Eutrochrepts, along with Haplufepts, Natrustafs and Haplustepts. Raj Kumar (1992) suggested that these soils should be placed at family level i.e. saline or alkali. Ahuja et al. (1992) stated that areas bordering the desert periphery of Rajasthan having low
rainfall, hot summer season and scanty vegetation covering the south western parts of the Haryana state, comprises of Aeolian plains with sand dunal activity. Bhiwani is one of the districts of Haryana state dominated by aeolian activity and comprises of sand dunes of moderate to high intensity. They occur in the south and western parts of the district and cover an area of 99676 hectare (19.5%). The aeolian plain was further divided into active, partially stabilized and stabilized gently undulating. The other major landforms of these areas were fluvio-aeolian, alluvial, aravallis and pediments. The fluvio-aeolian plain is covered with wind blown material which mainly comes from the adjoining active dunal areas. The plain is cultivated with slight to moderate wind erosion and gently undulating topography. This plain on satellite imagery is identified by the total contrast (mainly red) depending on the intensity of cultivation and vegetation. The sand cover is mainly distributed in the Northern and Southern parts of Bhiwani i.e. Siswala, Atela, Badal, Palri, Berla etc. The plain is further differentiated into sand dunes, interdunal depressions, sandy plains and low-lying plains. These two major landforms are the result of aeolian and fluvial processes. Sawhney et al. (1992) studied the pedogenesis in relation to physiography in semi-arid and arid tract of Punjab. He classified young and stratified soils from unstable landforms as Typic Ustipsamment and Typic Ustifluvents. The severely eroded and shallow soils of foothills were classified as Typic Ustrorthents. Sidhu et al. (1994) observed that Entisols mostly occur on convex hill slopes, active and recent flood plains and in sand dunes. Similar findings were also reported by Goyal et al. (1989) and Sexana (1992). Raji et al. (1996) suggested aggeric epipedon for some man made epipedons which
have less than 250 mg kg\(^{-1}\) of P\(_2\)O\(_5\), lower organic carbon and are less than 50 cm thick. Gill & Arora (1997) studied the morphology and sedimentology of soils of SW Panjab. They concluded that the genesis of dunes in some semiarid areas of SW Punjab is partially from paleoalluvial sediments and partly from near by Thar desert. Jassal et al. (1997) studied the soils of submontain plains of Punjab for the effect of sedimentary processes on soil formation. They concluded that the soil variations are more due to sedimentary processes rather than the influence of pedogenesis. Walia and Rao (1997) reported that bulk density increases with depth possibly due to enhanced compactness with depth, low organic matter and or close packing of particles during settling of sediment. Jassal and Gill (1998) used the grain size data to work out pattern of clay illuviation in alluvial soils of Punjab and concluded that textural characters of the soil profile are related to the pedogenic processes. Parkash et al. (1998a) carried clay mineralogy of soils of central Indo-Gangetic plains of India. He related the mineralogy of clay with climatic changes during Halocene. Parkash (1998b) studied the soils in west Bengal and tried to work out the evolution of Lower Gangetic plain landforms during Quaternary. Iqbaluddin et al. (1999) studied the Terrain mapping unit-based approach for sustainable agricultural development in India - an example from plains ecosystem at semi-arid interface. Yadav (1999) observed good geomorphic-soil relationship in Haryana. Jassal and Gill (1999) studied the relationship between the soil characteristics and the sedimentary processes in alluvial piedmont soils of Siwalik foothills. Three categories of soils have been differentiated depending upon the profile development in piedmont zones. The changes in
characters have been suggested to be a function of sedimentary processes involved in the deposition of the parent material. Parkash et al. (2000) identified some tectonic blocks in the western Gangetic plains using the soil-geomorphic approach along with the distribution and degree of soil development. They inferred the timing of block movements with help of luminescence dating of the soils. Basirani and Gill (2001d) opined that the particle size distribution, organic matter content and bulk density of Hisar soils are helpful in estimating some of the significant soil water characteristics. Basirani and Gill (In Press), while Studying the Hisar Soils have suggested the distribution of available micronutrients depends upon the soil characteristics. A specific pattern of distribution of available Cu, Mn and Fe has been noted due to alluvial nature noted due to alluvial nature of soils. They have concluded that the Hisar soils are deficient in available Zn, medium in Cu and low to medium Mn and Fe.