# 2 History of Soil Research

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**Abstract**

The knowledge of soil science is as old as civilization and was used even from Vedic times around 700 BC. Kautillyas' Arthashastram (400 BC) mentioned the improvement of soil fertility and growing rice and wheat crops in the fertile Indo-Gangetic valley. Information regarding the systematic study of western agriculture dating from the fourth century is available. Studies by Robert Boyle, Francis Bacon, Arthur Young, Justus von Liebig, and Birkland–Edie and Haber, among others, on the development of soil fertility and fertilizer are remarkable. It was Vasily Dokushaev's work in soil genesis in 1983 that the International Union of Soil Sciences recognized and led to their including soil science in International scientific society. The Nepalese history of soil science dates to 1957 when soil science was established as a unit under the Department of Agriculture to conduct soil sample analysis and soil fertility experiments. Later other units were added and gradually the number of people working in soil science increased but not sufficient. Scientists with soil science as an academic qualification are lacking in the world by 40%, Nepal has the same fate. While the national priority has been on higher food production, little thought has been given to the negative consequences of our actions, including land degradation and desertification. It is imperative that we should work hard and convince society and policy-maker that proper attention is given to restore soil fertility and soil health before it is too late, therefore, soil will continue to provide the nation with goods and sustainable services. In this chapter, we present a brief history of soil science established in Nepal and discuss how it develops with time.

**Keywords**

Agriculture • Nepalese farmers • Panchayat system • Rana regime • Soil Research • Soil Science education

## 2.1 Introduction

It is believed that the science and art of agriculture began with the evolution of human beings. Agriculture was believed to be the main component of economics since the third century. Farmers in those days classified land into four types based on their productivity, and in general, farmers could identify these different land classes: best, intermediate, moderate, and marginal. The system of green manuring in soil was also practiced, and locally available potential green manuring crops were often incorporated during tillage operation. Farmyard manure (FYM), sheep and goat manure, poultry manure, kalimati (black clay), etc. were the main sources of nutrients, and these methods have been practiced since ancient times. To keep the soil more fertile, crop rotation or the integration of legumes in the cropping system was practiced. Terracing was also practiced in the land that was sloped. Most often, Nepalese farmers worked in groups for preparing land, facilitating irrigation channels, transplanting rice, weeding, harvesting, threshing, winnowing, and even in safeguarding farms from wild animals.

When we consider the history of agriculture in Nepal, systematic agriculture dates to the Rana reign where several seeds, saplings, and animal breeds were imported from the United Kingdom during 1850 by Janga Bahadur Rana. Nepal had its first agriculture office or Agriculture Council established vis-a-vis an experimental area for agricultural research in 1922. There is some information about the irrigation projects developed even during the Ranas' autocratic regime. An irrigation channel (*Chandra Nahar*) at Saptari was established for agricultural purposes between 1926 and 1927. In 1937, an agriculture technical school at Chhauni

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was established to impart agricultural knowledge, and in the same year, an agricultural research area was also established at Baishdhara, Balaju. In 1947, one agriculture farm at Parwanipur of Bara District, and another small farm at Kakani were established in 1951. Parwanipur is still an important Agriculture Research Station, though Kakani was handed over to other government agencies after the 1990s movement (in 2029 BS - Nepalese date). The substantial irrigation development during the early period of Nepal is well documented by Gautam (2012). Apart from irrigation development, no other achievements are mentioned in the history of agriculture development and research activities. The low population during that time suggests that the rice crops harvested on that land were sufficient for the population. Population statistics show that there were only 8,256,625 people in Nepal and production was sufficient (Maharjan and Khatri-Chhetri 2006).

We get food, fodder, and renewable energy from soil, including buffering, filtering, and the transformation of clean groundwater. However, to meet the demands of a growing population the natural way of meeting humankind's needs has been exploited. M K Gandhi said, "Earth provides enough to satisfy every man's need but not every man's greed." Presently humans have overused the amount of natural resources and paved the way for a global tragedy (Singh 2011). Thus, civilization's challenge is to reconcile the demands of human developmental intolerances with nature.

It has been established that settlement began in the fertile alluvial soils by riverbanks and gained development momentum through river valleys in Asiatic regions. Human settlements seem to have developed at almost the same time in both western and eastern societies. Indian literature makes clear that cultivation of the subcontinent began sometime between 1000 to 500 BC. In Hindu mythology the Ramayan illustrates that King Janak (ca 500 BC) plowed the drought-stricken field and unearthed Sita, indicating that cultivation was already present. Even in Veda (1000 BC to 800 BC), the land was classified based on its level of fertility, such as '*urvara*' for fertile land and '*unurvara*' for infertile land (Abrol and Nambiar 1997; Blume 2014). Soils that are suited for rice, sesame, and other cereals differed. Another piece of Vedic mythology, Kautillya's Arthahsastra (Chanakya c. 350 to 283 BC) notes the need to increase agricultural productivity and farmers' income. Similarly, rice, wheat, and barley were first grown in the Indus and Ganges river valleys. Evidence shows that soil was plowed several times before seeds were sown and bullocks were used to plow the field. While animal husbandry was practiced and cow dung was used as manure during the same period, there is no record of any one individual pioneering these activities.

## 2.2 Soil Fertility in the Western World

Agricultural development and soil fertility maintenance in the Western world are well documented, in Aristotle's Human Theory (350 BC) among other sources. Winiwarter (2006) covers the ancient Greek and Roman scientists who documented agricultural development at that time. Among them were Cato (200 BC), Varro, and Columella during the early period of the Roman and Greek Empire, who covered agricultural practices, soil husbandry, and the relationship between humans and the soil. Later, van Helmont (1574 to 1664) experimented with willow plants growing in soil for 5 yr while adding only water, concluding that water was the source of plant nutrients as he found that only 200 g of soil from the original 5 kg was lost. Robert Boyle (1661) conducted a similar experiment and published his results on the importance of humus, which came from the decay of plants and animals. In the 1800s Humboldt recommended the use of guano in agriculture. Later, Justus von Liebig made an important discovery on the use of synthetic fertilizer in agriculture (1830). Birkland–Edie (1903) processed nitrogen (N) synthesis, and Fritz Haber (1918) manufactured ammonia fertilizer. Despite the many scientific publications on soil and related fields, soil science was not considered a science until Dokushaev (1883) published a report on soil genesis.

The soil in most countries has been always related to agricultural production. It is accepted that increased food demand can be met in three ways: increasing the amount of land for cultivation; creating higher crop yields per unit of land area; and reducing postharvest losses. Although the substantial but marginal amount of land area can be increased, scientists and planners believe that a greater part of the increase must come from a higher yield. The United Nations Food and Agriculture Organization (UNFAO/ FAO) predicted that by the year 2050 world food production of cereal must increase by 940 Million tons (M t) to reach a total of 3 billion (B) t, meat production must increase by 196 M t to reach a total of 455 Mt, and oilseeds must increase by 133 M t to reach a total of 282 M t (Alexandratos and Bruinsma 2012). Since the ability to expand the land area in most countries is limited, efforts must be made to increase crop yield per unit area. The FAO has estimated that more suitable land could also be brought under cultivation, though the exact location of this land has yet to be identified (Young 1999). The FAO estimates that to meet the targeted production of food by the year 2050, prime agricultural land of 132 M hectares (ha) can be brought under cultivation in sub-Saharan Africa and Latin America, leaving 1.3 B ha as free land (Alexandratos and Bruinsma 2012).

## 2.3 Agriculture Research Development in Nepal in the Post-Rana-Regime (1951–1961)

Prior to the 1951 democratization of Nepal, the Ranas in 1935 initiated some development activities, though these efforts were not enough to reach the people. They created the Agriculture Board, the Bureau of Mines, the Forest Office, and the Industrial Promotion Office, but these entities never materialized. Similarly, in 1949 the National Planning Committee also was formed, and a 15-yr plan was formulated but never executed (Dhital 1970). Due to country-wide dissatisfaction and the people's movement, the Ranas' autocratic rule ended in 1951. When they left, they had built up practically no development infrastructure during their 104-year rule.

After Nepal's democratization, it was up to the country's democratic leaders to transfer the ancient society to a modern one, though the king was still the head of state. The country's administrative infrastructure was well established, whereas developmental activities needed to start from scratch. Technical manpower was needed in every sector, ranging from housing, road, education, irrigation, forest, and agriculture. Nepal and the United States signed the Four Point Agreement on Technical Cooperation just a few months before the collapse of the Rana Regime in 1950, under which many Nepalese scholars were sent for training and higher education to different countries (Skerry et al. 1991). At this time, the Department of Agriculture was established in 1952 with very little technical manpower. At the same time, Nepal joined the Technical Cooperation Scheme of the Colombo Plan in 1952, received scholarship funding, and sent many Nepalese to study in foreign countries (Dhital 1970; Pant 1956). Similarly, in 1956 another agreement was signed with the US International Cooperation Administration to train 1,700 people for technical manpower building through education and training. It was the beginning of technical manpower building in Nepal. With the initiation of USOM, a soil laboratory was created in Kathmandu (Min Bhavan) in 1953 (2010 BS), which was later shifted to Harihar Bhavan and in 1971 to Khumaltar, where the Soil Science Division has operated since then.

Following the visit of Mrs. Eleanor Roosevelt, the former first lady of America (31 December to April 1952) during the monsoon season of 1952, there was a massive flood and landslides. In 1954, there was another landslides and flood that killed more than 1,000 people and left 100,000 homeless. The people in western hills suffered the most, and were in desperate need of food grain (Annonymos 1959). In the first year of disaster relief was provided in the form of food aid by the U.S. Operations Mission (USOM), and the following year Indian Aid provided fertilizer that coincided with Malaria Eradication Program in the Tarai and river valleys. As mentioned by Skerry et al. (1991), an American agriculture scientist and five former American Extension Agents were engaged in different agriculture improvement programs. He invited an American Soil Scientist (Surveyor), who formed a soil survey team with two Indian soil surveyors and surveyed the valley floor to understand soil fertility and resettle the flood and landslide victims from the hills. During that time, they established a field-level model soil laboratory in 1953. Some 5,000 families resettled on 12,000 ha of land, although there was 100,000 ha of land available to reclaim in the Rapti Valley. The Chitwan Valley was one such area where these flood victims were resettled, and modern agriculture was practiced there using improved crop varieties and fertilizers.

The fertilizer donated by the USOM and the Indian Aid Mission was mostly ammonium sulfate ($NH_4SO_4$), single superphosphate (SSP) and muriate of potash (MoP), and was distributed through Tribhuvan Gram Vikash Samiti (TGVS), an integrated rural development program that ran from 1956 to1962 (FAO 2010; Gurung 2011). The Gram Sevak (extension agents from TGVS) demonstrated the use of the fertilizer and distributed it to the farmers in some of the selected districts. The TGVS program was later run by the Youth Program of the Department of Agriculture in 1962 (Dhital 1970). After the program of TGVS, it was handed over to the Youth Program, the District Agriculture Development Office (DADO) included farmers' field fertilizer demonstrations in their overall program.

When the Department of Agriculture was first created in 1951 there was limited technical manpower available. The USOM established soil laboratories in the field in 1953 and at Kathmandu in 1956, while technicians trained in chemistry were recruited for soil sample analysis. In addition to Parwanipur, the Rampur model farm that was established in 1953, agriculture research stations in Bhairahawa, Nepalgunj, Janakpur, and Tarahara were instituted in 1956 and 1957. After 1957, qualified agriculture graduates began returning from abroad, soil fertility experiments and pocket soil surveys of the area's agricultural potential were carried out. A cartography unit was also developed to prepare a soil map. Soil fertility experiments were extended to other farms as well. More graduates returned from abroad after receiving their bachelor's degrees and joined the Department of Agriculture, and some were recruited into the Soil Science Section. All the soil scientists went to the field for soil surveys and after their fieldwork conducted laboratory analysis of soil samples. The soil survey team began writing reports and began other soil fertility experiments, though they were very limited. In 1960, King Mahendra sized control and suspended elected parliament and multi-party politics, and in 1962 promulgate a new constitution and one-party Panchayat system was implemented.

## 2.4 Soil Science Under the Panchayat System (1962–1970) to Present

There has been a gradual increase in the number of soil fertility experiments in Nepal since they began. Variety cum fertilizer trials were the major experiments in different crops in different research stations. The Kakani, Khumaltar, and Rampur farms mostly concentrated around maize and soybean experiments. Other farms and stations experimented mainly on wheat and rice crops. This was the period when the Agriculture Association was registered and the Nepal Agriculture Journal began publication once a year thereafter. Several of the experiments conducted in different research farms and stations were published. Fields such as crop research, horticulture, livestock (including veterinary and fisheries), and agriculture extension were all included under the single Department of Agriculture but were headed by section chiefs who were academically qualified and had experience in their respective fields. This was followed by a major change in the agricultural structure, in which the single department was divided into five departments, viz. Crop Science, Horticulture, Livestock and Veterinary, Fisheries, and Agriculture Extension. Soil Science was included under the Crop Science section. Until 1970, graduates in agriculture from India and some from the USSR joined the Soil Science Division, after which scientists were assigned to a different unit in the section. This led to the strengthening of the soil physics laboratory and soil microbiology unit.

Although work in soil science began as early as 1953, actual recognition was made in 1957 when the Soil Science Section was set up as a unit under the Department of Agriculture, then His Majesty's Government (HMG) of Nepal headed by Bidur Kumar Thapa. This unit conducted a soil survey, soil sample analysis, and soil fertility experiments from various resettlements programs such as the Rapti Valley Development Program and the Banke and Bardia resettlements program. Later, units such as soil survey, soil physics, soil microbiology, plant nutrients, and recently Geographic Information System (GIS) and remote sensing were added. Soil scientists were posted to the Khumaltar and Parwanipur stations only. More soil scientists were added to Tarahara Agriculture Farm, Janakpur Agriculture Farm, Rampur Agricultural Station, Bhairahawa Agricultural Station, and Khajura Agricultural Station in 1972.

Farms established for the purpose of agricultural development felt the lack of soil scientists and recruited additional soil scientists in their command area. These farms and stations were GADP Khairenitar, JADP Nakatajhij, Agriculture Center Lumle and Pakhribas, and Hill Agriculture Station Kavre. Other farms and stations where soil scientists were recruited were Agricultural Station Doti, Jumla Agricultural Station, National Citrus Research and Development Centre Paripatle, Kirtipur Horticulture Station, Malepatan Horticulture Farm, and the Tobacco Development Program. The farms and stations were assigned to conduct soil fertility experiments mostly variety cum fertilizer trials and to collect soil samples for analysis to send to Khumaltar. The soil laboratory at Khumaltar was overloaded and additional soil labs were set up in some farms and stations, including Tarahara, Parwanipur, Rampur, Bhairawa, Khajura, and Khairenitar and later Lumle Agriculture Centre and Pakhribas Agriculture Centre.

After the partition of the Department of Agriculture (DoA) and Nepal Agricultural Research Council (NARC) in 1991, additional soil laboratories were set up. Nepal Agricultural Research Council concentrated on soil related to research and DoA in development activities such as providing soil analytical services. The soil laboratories that DoA presently owns are at Surunga (Jhapa), Jhumka (Sunsari), Hetauda (Makawanpur), Harihar Bhawan (DoA, Lalitpur), Pokhara (Kaski), Nepalgunj (Banke), and Sundarpur (Kanchanpur), with soil scientists and required staff. Service provided by these government laboratories can sufficiently cater to the needs of farmers if all are run properly. Because the governmental laboratories could not fulfill the need for soil sample analysis, private soil laboratories were set up in Kathmandu Valley and outside as well.

Nepalese farmers applied organic manure mostly Farmyard Manure (FYM) to upland crops where maize and millet were grown. Rice crops depended on the organic matter-rich flood sediments that entered the field through irrigation. One source reported that 60 t $ha^{-1}$ of FYM had been applied by the farmers (Karki et al. 2007). A higher amount of FYM/compost is also applied in the Lumle Agriculture Research Command areas (Subedi and Gurung 1991). Use of green leaves of ashuro (*Adhatoda vasica*), tite pati (*Artemesia vulgaris*), masyang (*Vigna umbellate*), dhaincha (*Sesbania cannabina*), siris (*Albizia amluki*), and other succulent wild plants and leaves are still used to fertilize the rice nursery in the hills and mountain. In situ manuring by halting flocks of animals on different fallow land and shifting animal sheds during winter was practiced in early Nepalese agriculture.

### 2.4.1 Human Resources in Soil Science

The public profile of soil science and soil scientists in Nepal including other countries is on a level of the soil profile that is underground and largely invisible. Globally, some soil scientists have held the highest positions in international organizations such as the World Bank, the International Union of Soil Science, and International Agricultural

Research Institutes such as ICRISAT, IRRI, etc. These soil scientists also have received prestigious awards such as the Nobel Prize, as mentioned by White (1997), Australian Prizes, and the Wolf Prize for their work in soil science. Nationally, higher positions that soil scientists have held include Director-General of the DoA and Deputy Director-General (DoA), Joint Secretary at the agriculture ministry, Directors at NARC, the Dean of the Institute of Agriculture and Animal Science, and Dean of the Institute of Forestry. However, very little work has been done to persuade the public as well as the government to create new posts of soil scientists, whereas the need for soil scientists exists in every district and region and should be remedied if we are to save the soil and maintain sustainable food production in Nepal. It is not effective for the Nepalese government to recruit fertilizer inspectors with no knowledge of fertilizers and soil fertility from other faculties. Another example stemming from our lack of knowledge is that while major soil is lost from cultivated land and soil conservation activity is needed in upland cultivated fields, the Department of Soil Conservation is established under the Ministry of Forest. In short, professionals from other backgrounds are running soil programs without proper training and technical know-how.

With the limited number of soil scientists, we have implemented soil and fertilizer-related programs and are training technicians and farmers to balance the use of fertilizers for higher crop yield and soil management. However, farmers tend to forget soil fertility management when the program training and follow-up are terminated. There have been ample opportunities to create posts for soil scientists and extend our activities to each district, but this has not been possible. The number of scientists working in soil science has been decreasing every year, and this may be due to the government and society ignoring the importance of soil in Nepal. The same situation has been occurring throughout the world, and this has been a concern of the International Union of Soil Science (IUSS) as well.

In the developed world, soil science as a discipline has been slowly merged into other disciplines such as crop science, geology, ecology, and environmental sciences. Now, soil-related studies have been diverted through agronomic, environment, and their relation to human health. Though the number of soil scientists in the world has been lowered by 40% (Baveye et al. 2006), the number of research publications in soil science is increasing (Hartemink and McBratney 2008), indicating the importance of soil science. In Nepal also the number of soil scientists and students in soil science is diminishing even though we have hardly completed any work in saving our soils. This could be due to less attention from the Government of Nepal in the care and management of soil and land use. Recently the Ministry of Land Reform and Development is using soil pedology and soil fertility evaluation as a major component in its land-use zoning program country-wide. There is a high demand for soil science activities to save the most fragile mountain ranges in the world, which are increasingly threatened by large-scale human activities. Extensive deforestation and intensive farming on steep slopes, along with heavy population pressure on natural resources have resulted in overall environmental degradation (Shengji and Sharma 1998).

### 2.4.2 Soil Science Works Before the Formation of NARC

From the beginning, soil science as a unit began working in soil analysis and soil sample collection. Later, soil fertility experiments in cereals, particularly rice, wheat, and maize were conducted and presented in workshops organized within the Department of Agriculture. Around 1965 an expert in soil science from UNDP/FAO supported and guided Nepalese soil scientists in soil survey and mapping, including soil and water analysis. This strengthened soil analytical service, as all the members of soil survey, included soil fertility experiments and carried out soil sample analysis themselves. This assured the quality of the analytical results. Soil surveys of most of the districts in Tarai and Siwaliks have been completed, including some of the important hills and mountain districts such as the Andhikhola valley of Syangja, the Pokhara valley, and later, the Gandaki and Dhaulagiri Zones. However, very few reports have been published (Fig. 2.1).

In 1963, Dr. N. Borlaug came to India to implement his Green Revolution technologies. This revolution revolutionized fertilizer, seeds, plant protection chemicals, agricultural machinery, and water use. Intensive use of High Yielding Crop Varieties and NPK fertilizers including maximum use of water in irrigation no doubt increased crop production, but the project paid little attention to soil biodiversity, micronutrient exhaustion, and water pollution, including environments that were massively deteriorated due to soil mining and the effect of pesticides on downstream ecology. Activities of the Green Revolution were introduced in Nepal as well, and some improved varieties of wheat such as Lerma Roho 52 had already been introduced. As influenced by Green Revolution, DoA launched a UNDP special project, "Increase Use of High Yielding Crop Varieties and Fertilizer" (NEP-12, 1970–75). This project concentrated on improved varieties of rice, wheat, and maize where NPK fertilizer was applied in conjunction with irrigation. Several trials and demonstrations were conducted in the districts of Narayani and Bagmati Zones. This project NEP-12 impacted positively in the Tarai districts but had little impact in the hills. The remarkable impact of this project was the report of a reconnaissance soil survey of the Bagmati and Narayani

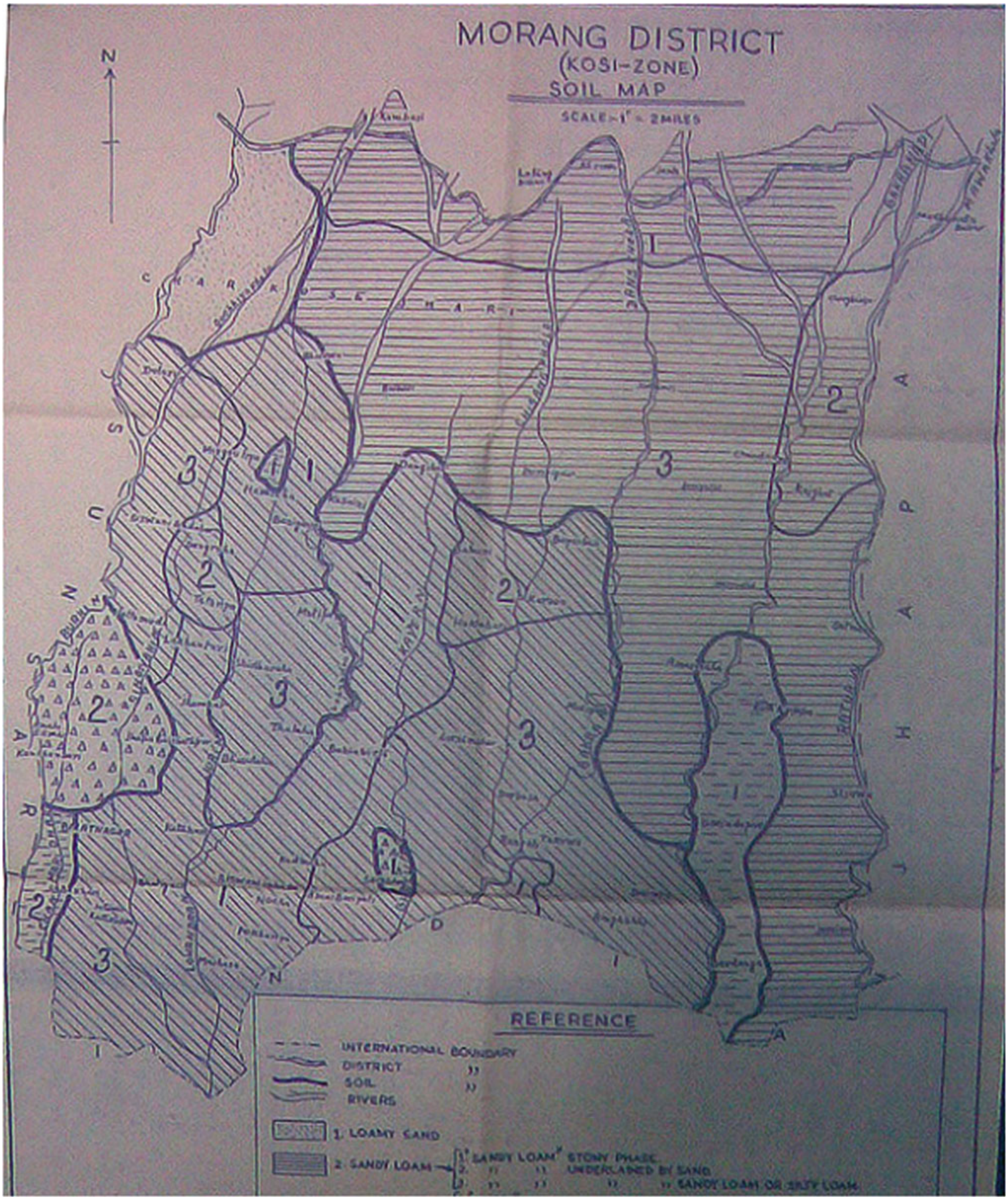


**Fig. 2.1** An example of early soil survey work done by the survey team. Previous days soil maps were hand-crafted but in the later decades they are digitized in Geographical Information System platform

zone of the project area. This was the only reconnaissance-level soil survey report and is still a good reference for the study of soil science in this area. For the hills, another FAO-supported project named FRIP was launched in 22 hill districts of the Western, Central, and Eastern Regions from 1982 to 1992. Similar activities of NEP-12 were replicated. This project came up with site-specific recommendations of NPK fertilizers for rice, wheat, maize, and potato.

Fertilizer did not respond well in the absence of irrigation and hence international organizations such as FAO/UNDP, ADB, the World Bank, and other multilateral and bilateral projects supported Nepal in its water use and constructed large irrigation plans. Many of these projects included feasibility and pre-feasibility studies and prepared soil maps of the command area for their use. Government soil scientists had very little knowledge of them. In addition, foreign universities have conducted academic as well as non-academic research on soil science and related fields in a scattered way. Most of the irrigation projects kept one demonstration farm within each irrigation project command area, which was later handed over to the Department of Agriculture to carry out demonstrations to farmers and produce quality seeds. Jhumka is one such farm in the command area of the Morang-Sunsari Irrigation Project. Later, the Department of Irrigation (DoI) implemented feasibility studies of major and minor irrigation projects where a soil survey was obligatory. However, most of the irrigation engineers did soil surveys and made soil maps as they liked.

### 2.4.3 Nepalese Soil Science at Present

Presently, soil survey in Nepal has been digitalized and computer-aided programs are used to prepare maps with the help of a global positioning system (GPS), which is much easier than in the days of hard-copy toposheets and aerial photographs. Laboratory procedures, including atomic absorption spectrometry (AAS), make use of highly expensive equipment, to detect individual elements. In just a short time, a soil survey report with a fully digitized map can be prepared.

Fertilizer experiments are a major task of the Soil Science Division (National soil science research center) in NARC. Some initial work in fertilizer use efficiency has also begun. Chemical and biological testing of some fertilizer products are included in these activities, along with digitizing previous soil survey work and participatory fertilizer experiments. Soil science in the Department of Agriculture mainly consists of concentrating soil fertility evaluation and mapping at the district level and providing soil analytical services to farmers. The Soil Service Directorate is also involved in helping the agriculture ministry to formulate fertilizer policy (Fig. 2.2).

### 2.4.4 Soil Research Carried Out by Education Institutes

The oldest agricultural institute (Institute of Agriculture and Animal Science) in Nepal is at Tribhuvan University (TU) where the master's in soil science program was started late and students conducted master's-level thesis research mostly through agronomic studies. Some academic studies are also related to soil erosion and conservation, including micronutrients, but all are agronomic.

The Institute of Forestry at TU also offers a master's degree in forestry where graduate students carry out research. They concentrate mostly on soil conservation, whereas students at Kathmandu University research environmental science. Several foreign universities also have conducted thesis research and/or collaborative projects with counterparts in Nepal, but the authors have access to very few records. Carbon (C) mapping studies, Likhu Khola Watershed studies, and many others are some examples.

## 2.5 Future Soil Science in Nepal

Soil science can be viewed through the perspective of a society's health and hygiene. Disease pathogens such as helianthus organisms and other worms can be housed in the soils and easily contaminate humans. The presence of radon-causing cancer is related to poorly drained soils and increases infant mortality rates (Oliver 1997). We do not know the health risk of poorly drained soils, despite most towns in the lower plains of Tarai being flooded every year. An excess of micronutrients and heavy metals such as aluminium (Al), arsenic (As), cadmium (Cd), copper (Cu), fluorine (Fl), iodine (I), lead (Pb), selenium (Se), thallium (Tl), and zinc (Zn) can be toxic when they contaminate food. In addition, soil deficiency in micronutrients results in low plant uptake, which ultimately creates micronutrient deficiency in humans. One of our results showed that most micronutrients (Boron (B), Zinc (Zn), and molybdenum (Mo)) are deficient in Nepalese soils (Karki et al. 2005). These deficiencies might have consequences on the health of our people.

Though we cannot take the right turn and begin these activities right away, some thought needs to be given on how we can increase food nutrients through biofortification. Biofortification of micronutrients could help improve the health of infants, children, and pregnant women (Bouis and

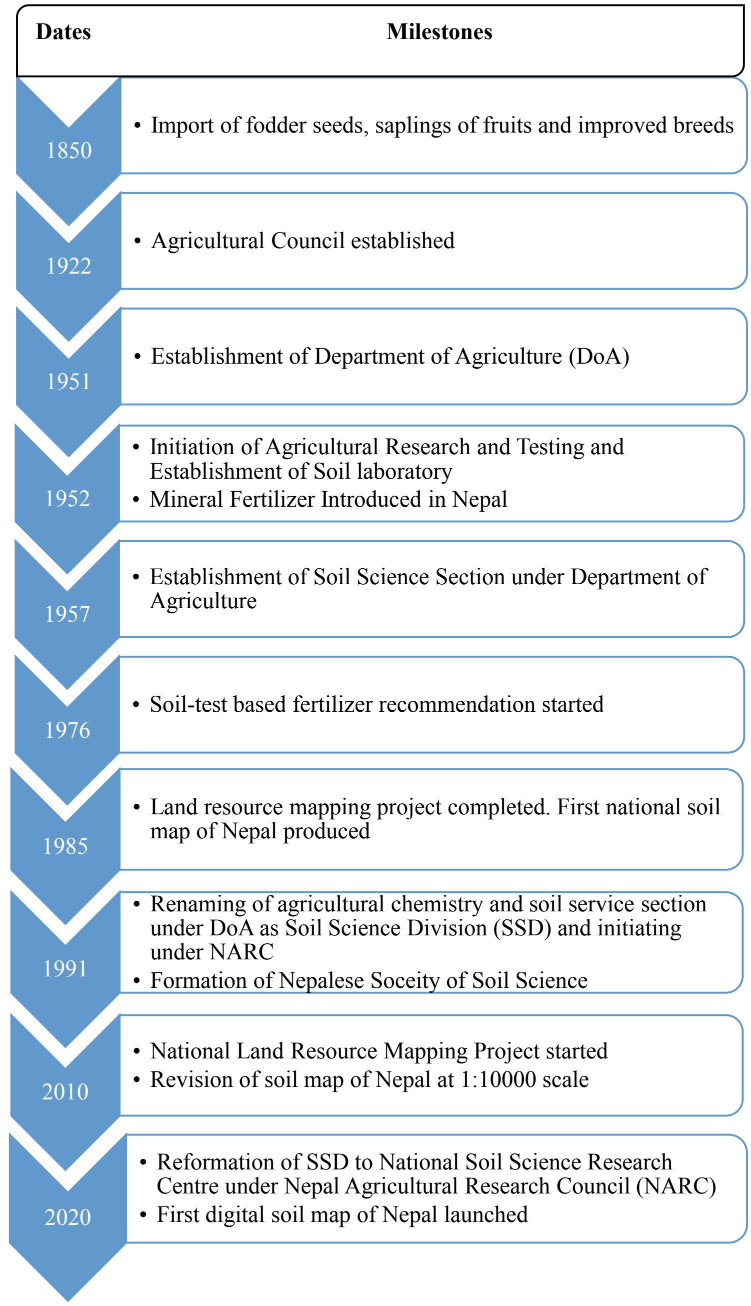


**Fig. 2.2** Soil science program development in Nepal

Welch 2010). Similarly, other avenues for increasing food nutrients need to be explored.

## 2.6 Conclusion

The soil history of Nepal dates to 5,000 years ago during the Vedic period, though it received formal address in the government sector only when trained soil scientists joined the Department of Agriculture in 1957. The first phase of soil science development was quite slow and mostly spent developing in-house facilities. Despite limited manpower, some remarkable work in the field of soil fertility has been conducted, including site-specific fertilizer recommendations for cereals, soil surveys to produce soil fertility maps, and soil survey reports of all the Tarai districts including some potential production pockets of the hills. Later fertilizer recommendations were included for potatoes, legumes, and some vegetables. As time passed, soil survey work was digitized, soil microbiology work was initiated, and soil micronutrient studies were reported. Still, soil research has been more focused on food security. We need to begin studying soil differently from a production perspective that includes the human medicinal value of soil, nutrient-enriched biofortification, and soil biodiversity. To explore different aspects of the soils of Nepal, studies in soil science need to be collaborated and documented by national and international agencies.

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