CHAPTER 2

Study Area and Sampling

The site selection is an important feature to get the representative results for the area. In order to study environmental pollution due to the use of phosphate fertilizers in saline soils, saline and normal soil, and patches were selected for the study. The selected area includes both normal and saline agriculture cultivated with fertilizers and having un-fertilized saline patch. The patches were selected in the two districts, Lahore and Faisalabad in the Punjab Province of Pakistan. The soils selected were such that they contained soils cultivated with fertilizers applied for different durations in different quantities. The area includes the Biosaline Agricultural Research Stations of Nuclear Institute for Agriculture and Biology (NIAB).The study area was demarked as site-1, site-2, site-3 and site-4. The cultivated soils of study area site-1, site -2 and site-3 have been regularly fertilized for thirty-five, twenty and twelve years respectively. There is a soil patch, site-4 included in study area, which was barren soil, with no treatment of fertilizers; it was taken as the control soil.

Sampling is an important feature, which provides the basis of results of an experiment. Sampling has been done in the plough layer (0 – 25 cm) to get the possible changes including chemical, mineral and radiometric in the soil and their effect on wheat plants.The samples have been collected and mixed thoroughly to make the representative samples of that particular site. In this section introduction of the study area including history, population, location, irrigation, geology of Pakistan along with the geology of Lahore and Faisalabad districts have been discussed in detail. The details of the sample processing drying, sieving, packing and storing, according to the International Atomic Energy (IAEA) protocols have been also discussed in detail, in order to get the reliable and representative results for chemical, mineral and radiometric analysis.

2.1 AREA UNDER STUDY

Our country, Pakistan is situated in the contient of Asia.The area under study lies in the central part of Pakistan. This area is situated in the Indus plains. This plain is formed by the river Indus and its tributaries. River Indus, which starts in the Hamalaya Mountain, is joined by the Jhelum, Chenab, Ravi and Sutlej rivers in the central Punjab. The study area belongs to Lahore and Faisalabad districts in the Punjab Province of Pakistan. The Indus River basin in Punjab and northern Sindh has fertile soil that enables Pakistan to feed its population under usual climatic conditions. Indus plains provide Pakistan with its best agricultural land. Canals carry the river water to many places in the plains. A large part of population lives in this area.The mighty river Indus is about 2,900 kilometers long.

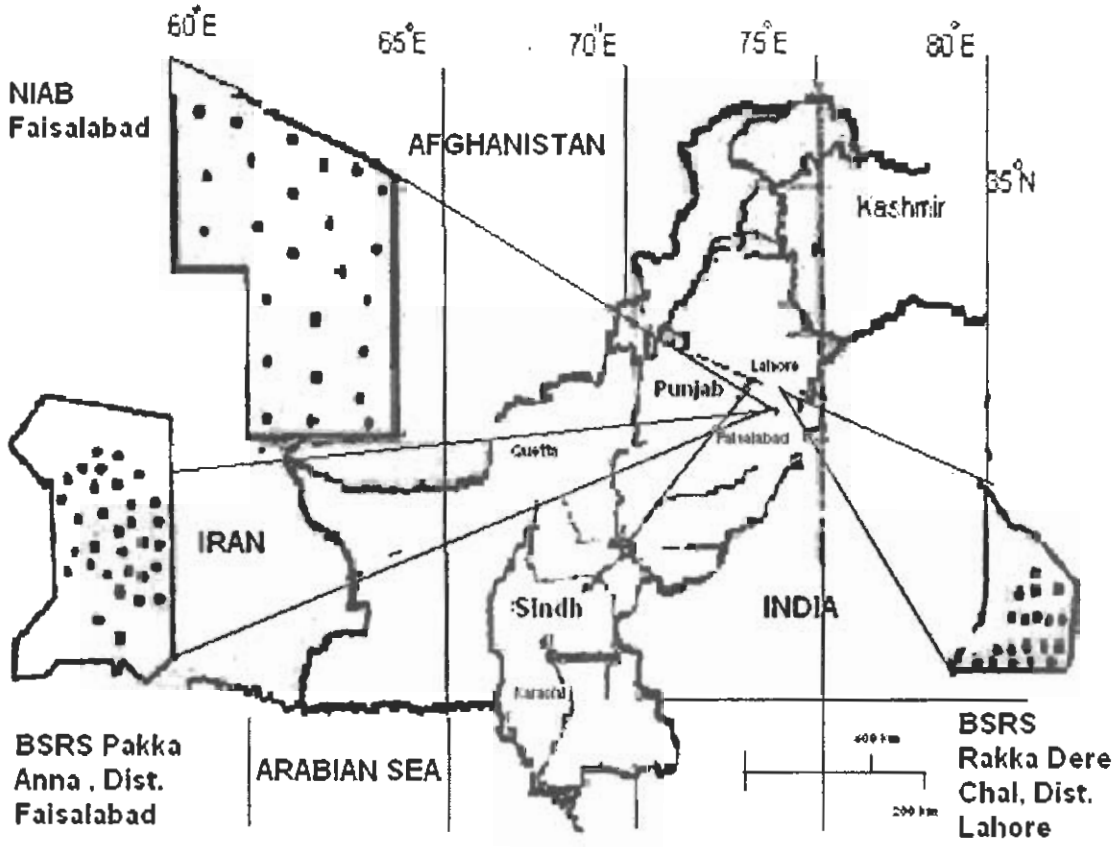


Fig: 2.1: Study Areas Shown on the Map of Pakistan

The Indus River is one of the longest rivers of the world, rises in south western Tibet only about 160 kilometers west of the source of the Sutlej River, which joins the Indus River in the province Punjab. The population of the area is 98% Muslim; the Eids are the festivals of the muslms which are celebrated in full swing with various concerts held in the arca.

2.1.1 Lahore District

Lahore district takes its name from it's headquarter city, which according to some legends was founded by Lahu, the son of Raja Ramayan about 4000 years ago. Heim-Tsang, the famous Chinese Pilgrim, has given a detailed description of Lahore city, which he has visited in the early parts of the 7^{th} century A.D. [2.1]. Lahore was thriving cultural center of the great Mughal Empire, and they beautified Lahore, with palaces, gardens and mosques. The buty of Lahore' was blended with the Mughal gothic and Victorian styles of architecture during British regime. Lahore district, presently consisted of two Tehsils, Lahore City and Lahore Cantonment.

In Lahore there are great buildings having historical architecture, including Badshahi Mosque, Shalimar Garden, Lahore Fort, and Jahangir's tomb. The main industries include silk goods, gold and silver lace, metal work and carpets. There are also cotton mills, flour mills, ice factories, several factories of mineral waters, oils, soap, and leather goods. This area is an important educational center. The major educational institutes include Punjab University with five affiliated colleges, Medical and Law colleges, Training College, Atchison chief college. There is an Atomic mineral centre institute and tomb of Sir Dr. Muhammad Iqbal, the thinker of Pakistan in this city. The study area no.2 lies in the district Lahore. The location of the area under study is shown on map of Pakistan in Fig 2.1.

2.1.1.1 Location

The Lahore district lies at 31° 15'and 31° 45' latitude and 74° 01' and 74° 39' longitude [2.1]. This area is bounded by Sheikhupura district in the north and west. The area is bounded on the south by Kasur district and India borders the area on the east. Lahore district is the second largest district of the country and is regarded as the cultural nucleus

of the Punjab. The study area consists of ten hectares along the famous Bari Rakh Branch (BRB) canal also called Rakh Branch. The name of this village (where stuy site-2 lies) is Rakh Dera Chall, which is situated at 30 km from the historical city of Lahore. The population of the village is 5000 persons. Majority of the people go to Lahore for work. Small portion of the villagers have small belonging of land and they use it to keep live stocks for their living and farming. The dimensions of the area are 31° 15'and 31° 45' latitude and 74° 01' and 74° 39' longitude as given in Table 2.1

2.1.1.2 Land Nature

Lahore district has an area of 1, 7772 km^2. The land of district is very fertile, as it is situated at the bank of river Ravi in the upper Indus Plain. The upper Indus basin, which includes this area, provides Pakistan with its best agricultural land. Bari Rakh Branch, Upper Chenab canals and their tributaries provide water for cultivation. The north - west of the district includes a large part of the Barren Rechna Doab, while south of the area is a desolate alluvial tract, liable to floods [2.1].

2.1.1.3 Irrigation

The Ravi the smallest of the five rivers which irrigate Punjab. It enters the district by the village "Ichogil" and runs through its entire breadth, and leaves it on the borders of Montgomery district.The great Bari Doab canal is an offshoot of this river, and it divides into several other branches, such as upper Chenab and branches which irrigate the area. The principal crops are wheat, pulse, maize, oil seeds and cotton. While quarter of the area is irrigated by tube wells [2.1].

2.1.1.4 Climate

There are two main seasons, namely the winter and the summer. The climate of the Lahore district has two opposite extreems. The maximum temperature in summer reaches upto 48 degrees Celsius. In winter it may, fall near the freezing point. The mean maximum and minimum temperaturs in summer are 48 and 38 degrees Celsius and in winter, 25 and 0 degrees Celsius respectively. The summer season starts from April and continues till October. May, June and July are the hottest months of the year, while

Table 2.1: Seasonal and Other Information about the Study Areas

Seasons and Climatic Properties	Study Area		
	Faisalabad Range (mean)	Lahore Range (mean)	Pakka Anna(mean) Range (mean)
Temperature			
Spring (February to April)	13-28 (20)	12- 26 (19)	16-26 (21)
Summer (May to July)	27-49 (38.99)	26 – 49 (40)	28- 49 (45)
Autumn (August to October)	27-35 (30)	25- 34 (29)	30- 36 (32)
Winter (November to January)	0 - 16 (12)	0 - 16 (11)	0 - 15 (10)
Humidity			
Spring (February to April)	04-16 (10)%	05-15(10)%	03-13(8)%
Summer (May to July)	04-06(05)%	05-16(8)%	02-12(7)%
Autumn (August to October)	20-40(30)%	20-40(30)%	20-38(29)%
Winter (November to January)	30-47.6(38.6)%	30-50(40)%	28.20-38..02(33.20)%
Rain (Annual Average) mm			
Spring (February to April)	240-440(320)	280-400(382)	200-400(300)
Summer (May to July)	280-400(340)	280-400(340)	220-430(380)
Autumn (August to October)	300-500(400)	300-486(450)	300-460(380)
Winter(November to January)	200-400(300)	280-400(340)	200-400(300)
Location	31024/ N 73o 05//E	30006/ N 740 07/ E	31015/ N 72049/ E
Amount of Fertilization use in Kg	500	400	321
Cultivation duration in Years	35	20	12
Elevation from sea level (m)	150	160	180l

December and January are the coldest months of the year. Winter starts from November and continues till March. The monsoons which are source of rain fall are at their peak in July and August. October and November are the driest months as given in Table 2.1.

2.1.1.5 Population and Cultural Setup

The population of district is about 6.34 millions, and growing at annual rate of 4.0 percent. The people of the area celebrate many traditions throughout the year, which belong to Mughal, Islamic, eastern and western trends. Eids, Basnat and Indepedence day are special days, which are celebrated at different places of the district. Many people decorate their houses and light candles to light up street and houses during these festivals.

2.1.2 Faisalabad District

The area was founded by the British in 1895 by Sir James Lyall. The first name of Faisalabad was Layallpur, after him as acknowledgement of his contributions in the colonisation of the area. The centre of Lyallpur was designed by Captain Poham Young, to imitate the Union Jack with eight roads radiating from a large clock tower in the centre to eight separate bazars.

The district grew into a strong industrial and agricultural centre by 1947. The name of the city was changed to Faisalabad in honour of the late King Faisal of Saudi Arabia. Prior to the British making the area into an urban center, it largely consisted of various villages [2.2]. However the construction of various canals allowed the area to be irrigated.

2.1.2.1 Location

The city district of Faisalabad is bounded on the north by the districts of Gujranwala and Sheikhupura, on the east by Sahiwal district, on the south by Toba Tek Singh and on the west by Jhang district. The location of the study area site-1 (Faisalabad city) ranges as 30° to 35° 6' latitude and 72° to 73° 6' longitude. The area under investigation consisted of 10 hectares of fertile soil at NIAB. The general elevation of land is about 150 meters above sea level. Out of total area of 14, 43703 heactares of land is irrigated through

canals (Jhang Branch, Gogera Branch). Rest of the area is either barani, cultivated by tube wells.

The other area is Pacca Anna which has study sites 3-4. This area is called the Bio Saline Rresearch Station number 2, which has been established by Nuclear Institute for Agriculture and Biology in 1992, about ten years after the establishment of first station, the land was acquired from government of the Punjab in 1992. This area consisted of 20 hectares of saline soil and located at a distance 34 km in the south west of famous city of Faisalabad. The variation of soil salinity is very high. The position of the area is 31° 24' latitude and 73° 05' longitudes at an elevationof 190 meters from sea level. It was not cultivated earlier but lying barren since decades. The shallow ground water is brackish, having high salt concentration. It is thus unfit for irrigation.

2.1.2.2 Land Nature

Faisalabad district consists of six subdivisions which includes Faisalabad city, Faisalabad saddar, Toba Tek Sing, Chak Jumera, Samundr, Tandlanwala and Gogera The general soil of Faisalabad district is fertile with some fraction of saline soils. Faisalabad district has been endowed by nature with rich soil, however some patches are saline. Aided by an efficient irrigation system, it has earned a name for agricultural productivity

2.1.2.3 Irrigation

The main canals, Jhang and Gogera branches irrigate most of the area of Faisalabad and one quarter of an area is irrigated by tube wells. The land close to the river is relatively lower than that away from the river in the west. The area is exceptionally favorable for canal irrigation. The farmland around the city has been improved by irrigation with new canals and new inhabitants were attracted by promises of land. Ravi flows along the southeastern boundary of the district. The major canals which irrigate the area, along with their tributaries.

2.1.2.4 Climate

Table 2.1 describes the climate of the Faisalabad. This district has two extremes; the maximum temperature in summer reaches upto 49 degrees Celsius. In winter it may fall near to the freezing point. The mean maximum and minimum temperature in summer are

49 and 27 degrees Celsius respectively. In winter the temperature range is from 21 and 6 degrees Celsius respectively [2.2]. The summer season starts from April and continues till October. May, June and July are the hottest months. The winter season, on the other hand, starts from November and continues till March. December, January and February are the coldest months of the year.

2.1.2.5 Population and Cultural Setup

The entire district had a population of about 5.8 million in 2003. It is the third largest district in Pakistan. It is an important industrial centre located in the centre of Punjab province, south west of Lahore. The city of Faisalabad is the city of textiles. Roughly, there are 512 large industrial units out of which 328 are textile units, 92 engineering units and 92 of chemicals and food processing units. There are also some 12000 household industries. It is an important transport and commercial center, especially for grains, cloth and vegitable oil.

As the history of Faisalabad is not old, it includes laborers, government servants and the owners of cloth business people as its residents. It is also an educational centre after Lahore. Agricultural University Faisalabad, Faisalabad University, several colleges affiliated with University of Punjab, Medical College, Textile Engineering College, several other colleges and high schools are working in the distric. There are three major agricultural research institutes in the city, which are Ayub Agriculture Research Institute (ARRI), Nuclear Institute for Agriculture and Biology (NIAB) and National Institute for Biotechnology and Genetic Engineering (NIBGE).

2.2 GEOLOGY OF PAKISTAN

Pakistan has an area of 79600 km^2 with a complex geological structure, which reflects its location at the boundary of the Eurasian, Indian and Arabian plates. Pakistan shares border with Iran in the west, Afghanistan in the north west. China in the nort east and India in the east. Geology plays an important role in the contribution of chemical, mineral and natural radioactivity level in any area. The four major zones, includes Northern Montain Areas, Axial Belt, Indus basin and Alluvial Plains [2.3] as shown in Fig 2.2.

2.2.1 Northern Mountain Area

The area north of the Islamabad Peshawar line constitutes the Northern Mountain area.

The ranges here are Himalayas, Karakoram and the Hindukush. Limestones, graywacks, shales, salates of Cambrian sequence overlay these rocks [2.4]. The limestone of devonain age forms the upper part of Northern Mountain. The lesser Himalayas are between 1,800 and 4,600 meters high. In these areas there are some beautiful places like, Muree, Nathiagali and Ghora gali. These mountains contain glaciers and snowy peaks including the famous Nanga Parbat in the Himalayan range [2.5] in Pakistan.

2.2.2 Axial Belt

This area consists of western highlands and is situated in the north west of the country. They began near the Makran Coast in the south and cover most of the Balochistan. They continue into the NWFP and Northern part of the Punjab. This belt is composed of sedimentary lithologies at places intruded by mafic and rocks from Permian to Pleistocene age, consisting of shales, sandstones, limestones, claystones, siltstones and some volcanies, are restricted to southern Axial Belt [2.6]. This area consisted of a complete sequence of rocks from Pre-Cambrian to Carboniferous age.

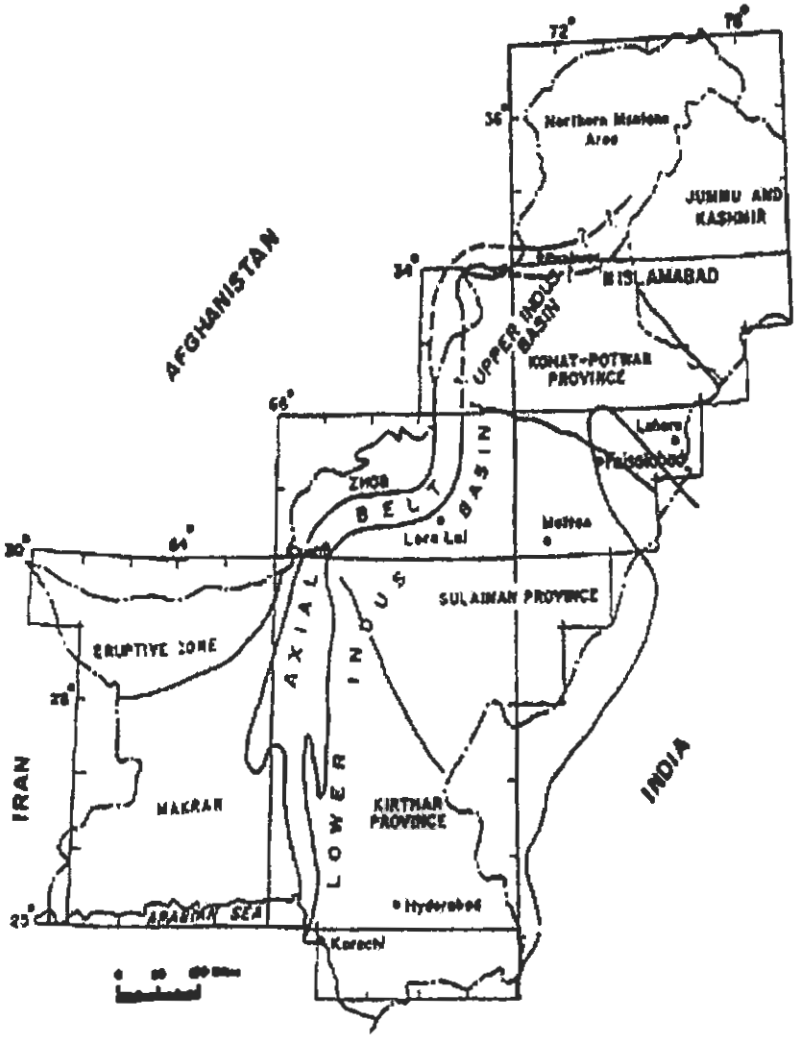
2.2.3 Indus Basin

This area is formed by the river Indus and its tributaries.The area adjacent to the east of Axial Belt, extending roughly from Islamabad - Peshawar line up to the Arabian Sea, is known as the Indus basin. It has been divided into two parts, upper and lower basins. The areas are shown in Fig 2.2, The details of these areas are given under.

2.2.3.1 Upper Indus Basin

This area has old rocks consisting of sandstones, shales, siltstones, dolomite/limestone, marls, etc from Pre-Cambrian to Pliocene with a gap of Ordovician to Carboniferous period. Permian overlies this rock sequence to Paleocene ideologies. Here rocks consist of marls, salt, dolomite, and gypsum. Eocene shales, sandstones, limestones and marls,

Fig. 2.3 Geological Map of Pakistan



followed by Miocene-Pliocene sandstones and shales of Murree, Kamlial and Siwalik formation overlie these rocks.

2.2.3.2 Lower Indus Basin

This area consists of a rock sequence of Cretaceous to Miocene age, it mainly comprising shales, siltstones, mudstones, limestones, and sandstones. Younger lithologies of Upper Miocene age, shales, sandstones, limestones, and shales of Siwalik formation are found overlying the older rocks.

2.2.4 Alluvial Plain

The area east of the Indus Basin is termed as Alluvial Plain. Salt Range marks the northern boundary of the plain; toward the south this plain extends up to the Arabian Sea. The plain contains some Pre-Cambrian granitic rocks at Nagar Parker near Karachi. The plain is mainly composed of alluvium, shales, and clays. The Western Highlands and the Indus plains are the major parts of Pakistan geology. These regions are quite different from each other. They have their own land form, climate and vegetation. These differences have an effect on the life of the people.

2.2.5 Geology of Lahore District

The area is a part of the natural unit known as the upper Indus Plains, which represent a geosynclines lying between the Himalayan foothills and the central core of the Indian Subcontinent. This depression has been filled with tremendous quantities of sediments brought down by rivers from the Himalayas, and has consequently turned into an alluvial plain. The rocks underlying the alluvium at great depth have no bearing on the soils. Although the entire area is an alluvial plain, different parts of the plain were deposited in different ways and at different times ranging from late Pleistocene to recent, as indicated by the degree of development of the soils and elevation of the land surface [2.6]. The area is drained by Ravi and Sutlej rivers and a number of nullahs, the Hudiara and Kasur, all of which flow in southwesterly direction. In the rainy season, their currents are very strong and they often go in spate, inundating narrow belts of land on their flanks.

High floods, however, are of very short duration and pass in a few days. Unchecked seepage from the canals has considerably raised the water table in some areas, causing widespread water logging and salinity. The salt content of the ground water varies from place to place and in depth, depending in part on flow patterns prevailing in the aquifer before and after the introduction of canal irrigation. The soil of study area was sandy clay loam.

2.2.6 Geology of Faisalabad District

This area is also a part of an alluvial plain between the Himalayan foothills and center core of the Indian Subcontinent. The alluvial deposit is generally more than a thousand feet thick and may extend down to several thousand feet at some places. This is the oldest landform in the surveyed area.

The scalloped interfluves, is probably of Late Pleistocene Age and comprises the flat-topped river terrace which is identified by the Kamalia Plain which comprises old and young floodplains of the Ravi river. These landforms can be further subdivided, such as level interfluves, old foot plains and young floodplain [2.6]. This area is of old flood plain, it comprises the early Holocene deposits of the Ravi and Chenab rivers and occupies the major part of Kamalia and small part of Chenab plains.

The soils comprise young stratified silt loams or very fine sandy loam having a weak subsoil structure with common kankers within five feet [2.6]. The courses of the rivers are winding and subject to the frequent alterations. In the rainy season, the water currents are very strong and often go in spate, inundating narrow belts of land on their flanks. High floods, however, are of very short duration and pass in a few days. Unchecked seepage from the Rakh branch and Gogera canals has considerably raised the water level active floodplain stretches in a narrow belt along the Ravi River and has a nearly level surface interrupted by flood channels running through it. The river bed includes the present river channels and their shifting sand bars and low sandy levees, annually flooded and liable to river erosion.

2.3 SAMPLING

Samples collected from the farms and received in laboratory may not be in the proper physical farm for analysis. They may require reduction in size, drying or some form of homogenizing before samples can be taken for analysis. Some general consideration for handling and pretreatment of the samples are presented in this section.

2.3.1 Soil Sampling

Soil samples are usually collected for studying either total deposition or the availability of radionuclides to crops grown in cultivated agricultural land. Ideally, a soil should be tested without disturbing or altering it chemically or mechanically in the process of sample preparation. This would require testing in situation, which is not technically feasible today. Successful soil testing depends upon the initial soil sampling.

The soil is a heterogeneous material; its color variation can be observed by the visual differences in surface appearance and in the profile. A routine soil sample weighs approximately one kg commonly referred to as a "Hectare furrow slice." [2.7].

The sampling locations were selected in such a way that they do not contain any abstraction like road, or wall and were plain land, from where vegetation has been removed. Soil sampling was done during the months of May and June in 2003. Samples were collected from four types of soils including normal and saline soils.

The study was a field experiment. The experimental area of each site was 10 hectares (25 acres). Sampling from soil patches was done using the Standard Sampling Methods [2.8]. These sites were divided into 10 patches. Soil sampling was done for 0 –25 cm depth in increments of 5 cm. The samples were homogenized to form 25 representative samples of each site.

2.3.1.1 Sampling Sites

These sites were selected in such a way that most of them had already been receiving fertilizer for the last many years in different amounts. Fertilizers were applied by means of spreader machines, so that each soil profile receive uniform amount of fertilizer. The sampling was done at the two Bio Saline Research Stations of Nuclear Institute for Agriculture and Biology (NIAB).

The normal soil was of NIAB farms itself, and was under regular cultivation practices going on since thirty-five years, named as normal fertilized soil it was regarded as site-1. First Bio Saline station was established by NIAB in 1990 near Lahore, where regular cultivation practices have been going on since 1980; it was regarded as site-2. The farm of Pacca Anna near Faisalabad was established in 1990 just ten years after the establishment of first station, by NIAB called as second Bio Research station of NIAB. Sampling was done for the two types of soils including fertilized and non fertilized soil. The saline soil cultivated with fertilizers is regarded as site-3, while the soil cultivated for one year without fertilizer was named as barren or virgin soil and regarded as site- 4.

2.3.3 Phosphate Rock and Fertilizer Sampling

The samples of rock phosphate were collected from rock heaps in various fertilizers manufacturing factories, research institutes, and phosphate deposits in Pakistan. The rocks originally belonged to the rock phosphate deposits in Jordan and Pakistan. The Pakistani rock samples were from the Hazara Phosphate Deposits in NWFP (North West Frontier Province) of Pakistan. The sampling of phosphate fertilizers includes the fertilizers factories, research institutes and the suppliers' shops in various cities of Pakistan. The details of phosphate rock and fertilizer sampling sites are given in Table 2.2.

2.3.4 Wheat Sampling

The sampling of the wheat plant and wheat were done for the uptake studies. The plant sample collection requires proper care to avoid degradation, spoiling or other decomposition and to avoid contamination. The sampling was done by the following protocols.

2.3.4.1 Wheat Plant

Wheat was grown in the agricultural farms of sites under study. Around 50 fully mature plants were collected from every hectare of the field and segregated into root, shoot and grain. Fresh weight of each part was noted down followed by washing with distilled

Table 2.2: Sample Collection Sites for Rock and Fertilizers.

	Sample Collection Sites/ Suppliers	Location City/ District	Rock Phosphate		Fertilizers					
			Hazara Phosphate	Jordan Phosphate	Urea	Nitrophos	Di-Ammonium phosphate	Triple phosphate	Tripple supper phosphate	NPK
1.	Agro Chemical Fertilizer Factory, Dahrki	Sukkur		1	1	1				
2.	Fauji Fertilizer Factory, Ghot Machi	Rahim Yar Khan		1	1		1			
3.	Haripur Hazara Fertilizer Factory	Hazara	1		2					
4.	Kakul Mirpur Phosphate Deposit	Hazara	1							
5.	Lagarban North Phosphate Deposit	Hazara	1							
6.	Laylpur Chemical Fertilizer Factory, Jaranwala	Faisalabad	1	2		2				2
7.	National Fertilizer Research Institute	Faisalabad	2	1			1	1	1	2
8.	Pak Arab Fertilizer Factory	Multan	2	2		2	2	1	1	1
9.	Pak Saudi Fertilizer Factory, Mirpur Mathilo	Sukkur	1	2						
10.	Sona Jordan Fertilizer Factory	Karachi	1	1			2	2	2	
11.	Aftab and Sons	Faisalabad			1	1	2	1	1	
12.	Al-Abbas and Brothers	Jhang						1	1	
13.	Ali Fertilizer	Mansehra			1			2	2	
14.	Combhoo Brothers	Faisalabad			1	1	1	1	1	
15.	Kisan Fertilizers Limited	Faisalabad			1	1				2
16.	Kisan Fertilizers Limited	Quetta				1				
17.	Shafi Fertilizers Corporation, Jaranwala	Faisalabad			2	1		1	1	1
18.	Sindu Brothers Fertilizers	Sargodha					1			
19.	Zia Fertilizer Company	Lahore								2
		Total	10	10	10	10	10	10	10	10

water in laboratory. The samples of wheat root, shoot and grain were collected seprately from the same site, where from soil samples were collected. The samples of soil and wheat plant were collected for each selected site.

2.3.4.2 Wheat Products

Parts of the wheat were used to make the wheat flour of each type of the wheat grown on four types of the selected soils separately. The flour was used to make the chapatti, for all the four types of flour. Total number of chapatti samples becomes as forty. Remaining flour was used to make the bread, nan and ruks from the four different bakeries under our supervision. All the pots used were cleaned and dried properly, so that the treated samples should be backed separately. All the collected samples were prepared according to the standard sampling methodology of IAEA [2.8].

2.3.5 Sample Preparation

The collected samples were used as representative sample of the material/site and were prepared / processed in the following steps for the reproducible results.

2.3.5.1 Drying

Samples were spreaded on clean surfaces, such as paper plates. Initial crushing of soil clods removed the pebbles and grasses etc. The soil samples were first put in the sun for several days. After crushing in small pieces and initial sieving the samples were dried in an electric oven at 100°C for 10 hours until the moisture of the soil could not further be removed.

2.3.5.2 Grinding

If the chemical and radiometric analysis is to be performed, it is essential that all surfaces coming into contact with the soil be stainless steel, plastic or wooden, preferably of a material, which cannot contaminate the sample. The dried samples were further ground, powdered until they passed through a sieve of mesh size 20 μm, so that clay and mineral particle may be homogenized to powder size of reference materials. Soil- 6 and soil-375 were provided by IAEA [2.9]. The weight of the standard samples was 500g each. The

proper homogenization of the solid sample is essentional for gamma spectroscopy system. The prepared sample of soil along with the standard bottle is shown in Fig 2.3.

2.3.5.3 Packing

Cylindrical plastic containers were used for filling and packing of the soil and other samples. The containers were of 75 mm diameter and 37 mm height. The container material was chemically resistant for the elements and compounds of soil. The containers were thick enough to prevent the permeation of radon. The net weight of the filled sample was noted by subtracting the weight of empty containers as shown in Fig.2.3.The containers were closed by screw caps and plastic tape was wrapped over the caps. The reference materials soil- 6 and soil- 375 obtained from IAEA [2.9] for system calibration was also packed, in the same fashion, in similar containers.

2.3.5.4 Storing

All of the samples were stored, for at least, 5 – 6 weeks to allow the secular equilibrium between ^{226}Ra and its short-lived daughters. Movement or escape of ^{222}Rn from the matrix-filled part of the container, which can result in erroneous measurement of the ^{226}Ra via ^{214}Pb and ^{214}Bi.

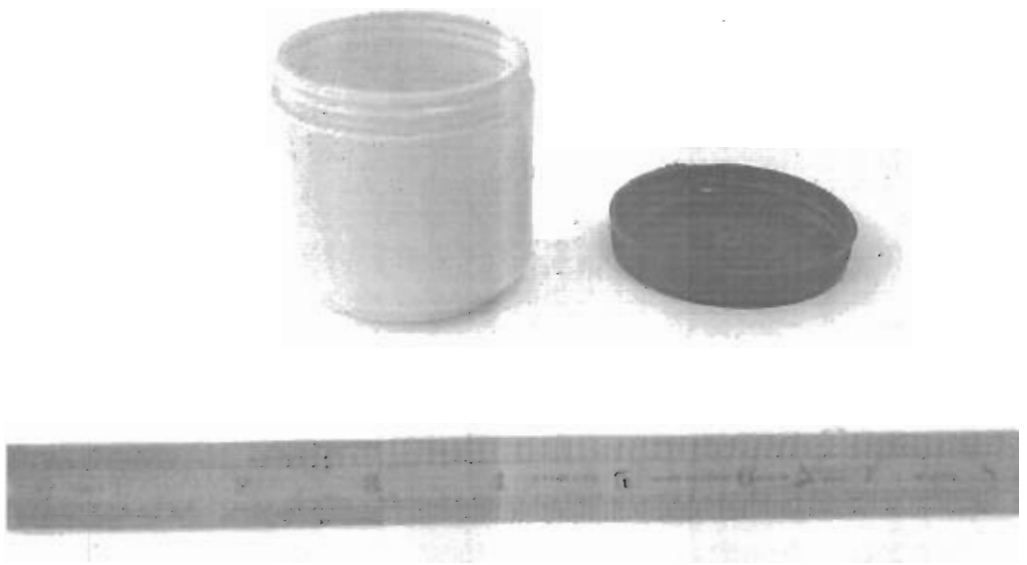


Fig 2.3: Sample Bottle for HPGe Analysis

An inner sealing cover was introduced in all the samples..The equilibrium time was calculated using the following equation [2.9].

$$t = \frac{1}{\lambda_2 - \lambda_1} \ln\left(\frac{\lambda_2}{\lambda_1}\right) \tag{2.1}$$

where λ_1 is the radioactive decay constant of ^{226}Ra and λ_2 is that of ^{222}Rn. The calculated time was about 66 days. If the activities of parent and daughter are plotted as a function of time it can be observed that after about 40 days the activity of ^{222}Rn approaches the activity of ^{226}Ra, therefore this time is considered to be sufficient to attain secular equilibrium between ^{226}Ra and ^{222}Rn. The reference material Soil 6 and Soil 375, stored at least for 40 days.

SUMMARY

This chapter gives the information about the two important aspects of the experiment planning. Site selection gives the information about selected sites. The selected sites were situated in two districts of the Punjab Province of Pakistan. The study sites lie in the Indus Basin, which have most fertile soil in the area. This area is irrigated by the canales which flow in this area. The sites were selected in such a way that they include fertilized normal, saline fertilized soils cultivated for different durations, (35, 20, 12, years). The fourth type of soil was the virgin or undisturbed soil having no fertilizer and is cultivated for the first time.

The study area includes Bio Saline Research Stations of Nuclear Institute for Agriculture and Biology (NIAB). The soil, fertilizers, plants and food stuff samples were collected and processed. The samples of rock phosphate and fertilizer were collected from research Institutes and Commercial markets.

The sampling protocol has been discussed for soil, plant and wheat products. Samples were dried sieved and crushed to attain mesh size 200 μm, then moisture free samples were packed into standard plastic bottles. The plastic bottles were closed by screw caps and plastic tape was wraped over the caps. The reference material soil - 6 and

soil -375 were also packed in the same way. The samples were stored to attain secular equilibrium between ^{222}Rn and ^{226}Ra and their short lived daughters.

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