AGRICULTURAL POLLUTION CONTROL PROJECT

STRENGTHENING CAPACITY IN CALARASI JUDET FOR SOIL AND WATER QUALITY MONITORING

ROMANIA AGRICULTURAL POLLUTION CONTROL PROJECT

Environmental Consultants Report on Soil and Water Quality Monitoring Program

by

Ms. Stefania Chiriac, Romanian Consultant and Ramesh Kanwar, International Consultant

A. Objectives

The overall objective of this project is to reduce the discharge of nutrients (nitrogen and phosphorous), bacteria, and other agricultural pollutants into the Danube River and Black Sea through integrated management of better on-the-farm agricultural and livestock management practices in the Calarasi region, specifically in the polder area along the Danube River. The project is designed as a pilot activity in the Calariasi county in the southern part of Romania and, if successful, will be replicated at similar sites in Romania resulting in substantial benefits to the Romanian surface and ground waters and the Black Sea. **The specific objectives of the soil and water monitoring component would be:**

i) to establish a soil and water monitoring program in the project area to monitor the current status of soil and water (surface and ground water) quality in the project area. This monitoring program will develop a schedule to collect monthly surface and ground water samples from selected drinking water wells, piezometers, surface drains, experimental plots, and Danube River for nitrate, phosphate, pesticides, and bacteria.

ii) to assess the institutional capacities of the Romanian Environmental Protection Agency and the Directorate of Public Health, Calarasi to undertake the work on soil and water sampling and analyses and make recommendations for capacity building, and

iii) identify measures to control soil and water pollution and specific activities that could be supported through GEF and other grants.

B. Background

Recent studies for the Black Sea watersheds have indicated that nutrient loads carried primarily by the Danube River to the have been responsible for the serious eutriphication problem of the northwestern part of the Black Sea. Studies made by the Black Sea Environmental Program (BSEP) have indicated that 58 % of the total nitrogen and 66 % of the total phosphorous flowing into the Black Sea come from the Danube River basin with more than 50% all nutrient loads coming from agriculture, about 25% from domestic waste and 10 – 13 % from industry. The major pathways into the Danube basin for phosphorous are direct discharges of runoff water, soil erosion, and sewage plant effluents (33% of P with surface water flow from agricultural areas, 31 % of P from soil erosion mainly from agriculture, and 30% of P from sewage effluents). Nitrogen loads to the Danube River come from direct discharges, erosion/runoff and sewage treatment plant effluents in more or less equal shares of 35% each, again agriculture being the source for

more than half the total nitrogen run-offs in many countries of the Danube River Basin. The Trans-boundary Diagnostic Analysis carried out on the basis of a pollution source inventory for the BSEP reveals that **Romania is the biggest contributor of nutrients to the Black Sea** as its entire territory drains into the Black Sea. In 1994, Romania discharged about 284 – 306 kilo tons of N and 39 – 40 kilo tons of P to Danube River. This includes about 44 % of the total N input from agriculture, whereas agriculture contributed about 58 % of total P. Groundwater pollution with nitrate and microbial organisms from agriculture is a major social concern in Romania. Between 1996-1999, forty-five cases of acute nitrate poisoning were reported in the proposed project area (Calarasi Judet) as a result of high nitrate levels in drinking water supplies. In 1997, a number of infants (less than one year of age) were diagnosed and hospitalized with acute nitrates poisoning. In fact, all cases of acute nitrate poisoning in 1997 in Romania were in the Calarasi Judet. Between 1996 and 1999, 59 samples from public wells and other water supplies in Calarasi were analyzed for quality. Of this, 45 samples (76.2%) exceeded bacteriological standards for drinking water and 47 samples (79%) exceeded the drinking water standard for nitrate. Twenty samples (39.9%) of the 45 samples that did not meet the drinking water criteria for Fecal Streptococus and 29 samples did not meet the criteria for Fecal Coliforms. Also, in the Calarasi region there is another health related epidemic from drinking water, spread of Viral Hepatitis type A. Approximately 90% of all cases are in the population group of school and pre-school children. Main reason is the lack of hygiene and good quality drinking water.

Romanian government has accepted on-the-farm environmental management an integral part of its strategic plan. About 80% of the arable land has been returned to previous owners and their heirs. However, only a select few new farm owners have farming experience, therefore measures are needed to provide support services on agricultural technologies and practices for increasing productivity and promoting conservation practices to preserve the quality of natural resources (soil and water). In response to this, the Romanian Ministry of Waters, Forests, and Environmental Protection (MWFEP) has proposed a pilot project on Agricultural Pollution Control to the GEF for funding to reduce the transport of nutrients and bacteria to Danube River.

C. Pilot Project Area

Project Site: The pilot project area consists of seven communas in the Calarasi Judet and is situated in the Southeastern part of Romania in Calarasi County. This area has about 74,200 ha of which 64,000 are arable land. About 40,000 ha of the arable land are in the terrace area above the Danube river. The remaining 24,000 ha of the arable land are in the Boianu-Sticleanu polder area, formerly a floodplain area. This area was drained in the late sixties and was converted into an agricultural polder. Now this area contains large areas of cultivated land, small areas of forests and degraded lands, and a small area of Iezer Lalarasi water body. 25,664 people reside within the project area most of whom are directly involved in agriculture.

Farmers in the project area practice intensive agriculture and drive major share of their income from agriculture. From the field observations it was very clear that agriculture is a thriving business in the pilot project area and farmers have indicated to use more fertilizers and pesticides to increase their productivity as their incomes grow. If current agricultural management practices are allowed continue, there is a great likely hood of further degradation of soil and water resources. Therefore, there is an immediate need of introducing better conservation tillage and crop rotation practices to reduce the leaching of nutrients from fertilizers and animal manure, pesticides, and bacteria to shallow groundwater and drainage/irrigation ditches.

Soils: The soils in the Boianu-Sticleanu Polder area are alluvial formed in stages during silting process of fines and sands within the floodplain and range from silt loam to sandy loam in texture

and are light colored indicating low organic matter contents. The polder soils have increased levels of salinity and acidity at several locations affecting crop yields. The soils on the terrace above the Danube river are carbon based chernozems, cambic chernozems, and clayed chernozems all of which are dark brown to reddish in color. These soils were formed on a loess base, with their texture being fine to medium. These soils are gently sloping, fine textured, with approximately 2 meters of soil over a layer of calcium carbonate leached from the topsoil. These soils are highly productive. Inherent fertility is high, but continuous deep tillage is obviously depleting the organic matter. There is further need to promote residue management and crop rotation practices, including the use legume crops, to maintain and increase organic matter by incorporating crop residue and animal manure.

Hydrology and Water Pollution: The climate in the project area is characterized by hot and dry summers and cold winters with frequent blizzards alternating with short defrosted intervals. A temperate climate exists along the Danube River with hotter summers and warmer winter months than expected in the terrace area above the polder. The average annual rainfall in the project area ranges from 500 mm to 600. The highest monthly average rainfall for June varies from 75.9 mm in Oltnita and 72.2 in Calarasi Judets. The average minimum rainfall month is February which brings only 30.1 mm in Calarasi and 30.8 mm. Most of the rainfall occurs during the summer months with frequent thunderstorms. Snow fall occurs in December through February with average January snow fall of about 90-100 mm. The water depth in the polder area varies from 1.5 m to 5.0 m whereas in the terrace area is deep sometimes going as deep as 15 m to 20 m. The major sources of surface and ground water pollution are: animal manure and waste handling facilities, agricultural fertilizers and pesticides, human waste from homes and municipalities, and domestic garbage and manure piles stored in the front yards near the individual village drinking wells. The potential for ground water contamination exist from poorly managed animal manure and waste handling facilities on the farms, nonpoint sources of pollution such as agricultural fertilizers and pesticides in intensively farmed agriculturally areas, and poor disposal mechanisms of human waste from homes and municipalities. Garbage and manure piles stored in the front yards, near the drinking wells, have been found to be another common source of ground water pollution affecting underground hydrology of the area. Most of the shallow ground water supplies in villages are contaminated with the presence high levels of nitrate. Some surface waters are showing signs of eutrophication with growth of water plants drainage ditches and streams, an indication of phosphorus pollution.

Water Management: Soil water management is an issue and concern for Romanian farmers which one of the major limiting factors affecting crop yields. During the 1980's irrigation was widely practiced in project area but since the changes in the political system in 1990, irrigation systems have become more or less ineffective. There is a need to rehabilitate these irrigation systems back. The Boianu-Sticleanu Polder area was artificially drained in sixties and was provided with dual drainage and irrigation systems using water from the Danube River. The water table depths in the polder area are very shallow ranging from 1.5m to 5m depths. During 1960's to 1980's, farmers were using very high application rates of fertilizers and pesticides and irrigation and drainage systems in the project area were considered a major source of nitrate and pesticide pollution of groundwater and Danube River through open ditch water system draining into the Danube River. Farmers would like to improve their water management systems by using irrigation practices and conserving all types of precipitation including rain and snow without. Conservation tillage systems could help increase soil moisture contents because of increased infiltration and reduced evapotranspiration. Keeping snow in the fields during winter months is another important practice to increase soil moisture contents from snow melt. This can be achieved by constructing shelter-belts and windbreaks along farm boundaries perpendicular to the direction of winter winds.

D. Soil and Water Quality Monitoring Program

Monitoring Program: An extensive soil and water quality monitoring program will be established for the proposed project area consisting of seven communas in the Calarasi Judet in Romania to monitor the changing quality of surface and ground water bodies that eventually are draining into the Danube River. Standardized water quality efforts are needed to provide decision-makers in Romania and the public with reliable data on problems and trends in water quality of the Danube River and its tributaries and the Black Sea. The Department of Environmental Quality (EPA) in Calarasi has a ongoing water monitoring program to monitor the quality Danube river at ten locations along Romanian border. EPA is collecting data on nitrate and phosphorus levels in addition to eight other parameters. The Directorate of Public Health in Calarasi collects weekly/monthly data on bacteria in several drinking water wells in the Cararasi Judet and the Danube River. Current ongoing efforts on collecting soil and water quality data are hampered by the lack of adequate financial resources, state-of-the-art laboratory and monitoring equipment and chemicals needed for the various analyses and maintenance of the existing water quality laboratories. In addition, there is a need to develop a standardized reporting system on soil and water quality data that makes the information available to all interested parties. Table1 gives a listing of various parameters to be included in the water quality monitoring program. Table 3 gives the proposed environmental assessment plan for the GEF Environmental Pollution Control project.

In addition to the ongoing efforts by the EPA and Directorate of Health in Calarasi, following will be the specific soil and water monitoring activities of this project:

i) A total of 20 new piezometers in the polder and terrace area of Calarasi Judet to sample ground water quality for nitrate, phosphorus, bacteria and pesticides; depth of these piezometers will be decided after ground water aquifer survey is completed which will include the depth of the water table aquifers, direction of groundwater flow and possible sources of groundwater contamination and at each of the 20 piezometer sites soil samples will be collected for nitrate and phosphorus analyses. The decision on the selection of these piezometer sites will be made after obtaining the hydrologic and land use maps.

The selection of piezometers sites was made by the local consultant, Ms. Stefania Chiriac, based on several criteria related to land use in the project area, the geohydrology of the underground soils and the groundwater flow direction towards the Danube River. On the basis of these criterion, following decisions were made on piezometer selection sites in the project area.

- A total of 5 piezometers will be installed on the up-gradient side of the northernmost boundary. Water quality data from these five piezometers will help us determine if groundwater pollution is occurring in the project area from areas located outside the project area. Essentially, data from these piezometers would serve the need of baseline data for groundwater quality.

- Another 9 piezometers will be installed down-gradient of the residential areas in the middle of the project area to survey the impact of combined activities carried out in the residential areas and the surrounding agricultural land between the northern boundary and the upper border of the lower polder zone.

- Last set of 6 piezometers will be installed on the down-gradient side in the polder area along the Danube River to determine the impact of the agricultural activities carried out in the polder area, which is located in the lowest part of the project area.

ii) Three drainage/irrigation canals and one natural open drain in the Boianu-Sticleanu polder area (near the Danube River and drain into the Black Sea) will be selected for extensive water sampling for nitrate and phosphorus analyses. A total of three to four sampling points will be selected on each of the four drainage/irrigation canals.

iii) A total of 20 drinking water wells will be selected (in selected villages of the project area) on farmer's farmsteads where cistern of drinking water wells near the surface will be modified to stop the seepage from surface water containing animal waste water near the wells.

Ms. Stefania Chiriac, Local Consultant conducted a detailed survey of the project area and decided locations of drinking water wells for sampling. The selection was performed on the basis of following criteria: i) based on the geographical location within the project area, ii) a maximum of one well in per village except the Ceacu village within the Cuza Voda comuna, and iii) the number of animals owned by an individual farmer(like cattle, pigs, sheep etc.). On the attached map, location of the these wells are shown by the letter C as given below:

- 4 water wells in the Northern part of the piloted area (C 09, C 10, C 18, C 17)
- 6 water wells in the middle of the project area (C 11 C 14, C 19, C 20)
- 10 water wells along the upper border of the polder area (C 01 C 08, C 15, C 16).

In addition to the selection of wells, for each of the selected well location, a specific checklist (Water Point Inventory Form) was completed giving data on some basic analytical analyses (electrical conductivity, TDS, temperature, pH) were performed and the static water level was measured. These data are presented in table 1.

Relevant pictures were taken for each of the well locations giving an indication of the potential pollution sources and the condition of the well cistern.

Table 2. Location of drinking water wells in the project area and some of the well water physical and chemical well characteristics.

Site	Village	Owner	Toposheet	Elevation	pH	Cond	Temp	TDS
C01	Andolina	RAIU Petre	L-35-139-A	19.0	7.2	3130	13.0	1570
C02	Sirbi	PAVEL Grigore	L-35-139-A	20.0		4350	14.5	2230
C03	Margineni	STAN Stefan	L-35-139-A	20.0	7.56	4450	15.0	2280
C04	Smirdan	TRIFAN Petre	L-35-139-A	20.0	8.03	4900	15.0	2540
C05	Bogota	FOGOROS Nicolaie	L-35-139-A	16.0	8.13	1800	16.0	890
C06	Rasa	STANCU	L-35-139-A	20.0	8.56	1865	15.0	920
C07	Cunesti	ANDREI Aurel	L-35-139-A	19.5	8.64	4800	14.0	2470
C08	Gradistea	CRAIA Mihai	L-35-139-A	20.5	8.6	4360	13.5	2220
C09	Mihai Viteazul	SANDU Andrei	L-35-127-C	40.0		1900	13.1	930
C10	Vlad Tepes	DIONISIE Constantin	L-35-127-C	40.0		2140	11.1	1050
C11	Nicolae Balcescu	MAGEARU Virgil	L-35-139-A	38.0		1820	11.2	874
C12	Alexandru Odobescu	PETCU Ggeorghe	L-35-139-A	25.0		2420	11.5	1180
C13	Galatui	DOBRE Florea	L-35-139-A	21.0		2960	11.4	1450
C14	Potcoava	MIHAI Vasile	L-35-139-A	25.0		1950	10.1	970
C15	Calarasii Vechi	CIRJILA Dumitru	L-35-139-B	15.0	7.42	1743	9.9	841
C16	Cuza Voda	ARPASANU Eftimie	L-35-139-B	20.0	7.45	1906	10.4	921
C17	Floroaica	MUSAT Dumitru	L-35-127-C	42.5	7.55	3010	10.0	1490
C18	Vilcele	GRUIA Gheorghe	L-35-127-C	42.5	7.26	2140	10.8	1040
C19	Independenta	SIRBU N.Ion	L-35-139-A	25.0	7.29	3030	10.2	1500
C20	Visini	PUISOR I.Niculaie	L-35-139-A	38.0	7.57	2230	10.0	1080

Note: SWL - Static Water Level

iv) Three demonstration site will be established in the project area to promote the use of better manure storage and handling facilities, and the use of conservation tillage and nutrient management plans to increase soil organic matter and carbon sequestration; at these three demonstration sites weekly/monthly samples for surface runoff, ground water, and soil quality will be collected to determine the impacts of the better agricultural management practices on soil and water quality and production. For fertilizer and manure management studies, the nutrient contents in the manure and soil profile must be analyzed so that calculations can be made on how many tons of manure or kg of fertilizer can be applied per hectare to achieve the desired application rates of N, P, and K from manure or fertiler to meet the N and P uptake needs of the crop. Any shortfall in the nutrient supply from manure can be compensated by applying mineral fertilizers. **Efforts will be made to develop a soil test for Romanian soils to improve soil quality and maximizing the efficiency of ferilizer/manure use.** The demonstration study site will analyze surface and groundwater water samples for NO_3-N, PO_4-P, pesticide residues. In case of manure application, water samples will be analyzed for E-Coli and fecal-coliform bacteria. Also, quantification will be made in terms of tons of soil lost per hectare from each BMP evaluated in the study. Chemical loss in terms of kg/ha loss of NO_3-N, PO_4-P and pesticides should be calculated for all the evaluated BMP's in these studies.

v) Water samples will be collected at two different sites on the Danube River for nitrate, phosphorus, pesticides and bacteria analyses (Table 2).

Table2. Monitoring parameters and laboratory analyses for soil and surface and ground waters quality for the GEF Romania Project

Purpose of Analysis	Analytical Parameters	
	Soils	Surface and ground water
General Characterization	Organic matter color texture hydraulic conductivity of soil profiles	pH Turbidity Odor Dissolved solids suspended solids
Water and soil quality hazard	Organic-N, TKN NO_3-N, total P, herbicide residues	NO_3-N, ortho and total P, herbicides and other selected pesticides used in the area, fecal coliform/total coliform bacteria
Salinity Hazard	Ec, Ca, Mg, Na, CO_3 HCO_3, SO_4, Cl	Ec, Ca, Mg, Na, CO_3 HCO_3, SO_4, Cl

Table 3. Environmental Assessment Plan for Romania Project: Environmental Impacts

Issues	Anticipated Potential Impacts	Effects	Actions
Surface water quality	i) Deterioration in quality as runoff waters from swine and cattle manure disposal sites, agricultural areas treated with manure and agricultural chemicals, natural streams/ river/open drains & other surface water bodies, which eventually drain to Danube River. ii)Runoff waters containing unknown chemicals and pathogens from villages and city sewage water join irrigation/drainage canals and Danube River to deteriorate the quality. **Probability of occurrence: High**	i) Decreased quality and availability of Danube River water and Black Sea coastal waters will result in less use of beaches by public and decreased harvest of good quality fish ii) Decreased utility of water for downstream users and fisheries if any. iii) drinking water supplies will get contaminated and could have health related effects as city of Calarasi uses Danube River water for drinking supplies	i)develop and implement improved manure management and environmental sound agricultural management practices Calarasi County of Danube River watershed ii)Undertake a rigorous surface water quality monitoring plan of Danube River and other surface water bodies that drain into Danube River (which eventually drains into the Black Sea) to establish a baseline database of the quality of surface waters, lakes and Danube River as affected by better agricultural and manure management practices.
Groundwater	i) Groundwater quality deterioration as a result of leaching of nitrogen, phosphorus, pesticides and bacteria from manure and human waste ii)groundwater water quality deterioration from leaching of salts from the selected areas . **Probability of occurrence: High**	i) Decreased quality and availability of groundwater for human and animal consumption and irrigation. ii) Groundwater is the main source of drinking for rural population and increased levels of nitrate and bacteria in water could cause water borne diseases in humans and animals.	i) Develop and implement environmentally sound and sustainable agricultural and manure management practices in the project area. ii) Implement wellhead protection programs for rural drinking water wells iii) Establish monitoring of groundwater resources used for drinking in highly intensive agricultural and animal production areas. iii)Monitor groundwater quality in piezometers and wells in areas with improved agriculture and animal waste management systems
Soil Quality	With the introduction of better farming systems, soil quality will improve **Probability of occurrence: high**	Better productive lands with increased organic matter and carbon sequestration	Undertake soil monitoring of selected areas to establish the effect of better farming systems on soil and water quality
Biodiversity	Increased biodiversity will occur because of better manure management systems, introduction of conservation tillage systems, forest areas, buffer strips etc. **Probability of occurrence: high**	Increased biodiversity	Observe impact on new plant and animal populations, and soil worm and microbial activity. Measure effects on soil organic matter and carbon contents, and possibly water quality.

vi) In order to assess the impacts of GEF investments in the project area through the introduction better tillage, crop rotation, and manure management practices on the water quality of Danube River, SWAT computer simulation model will be calibrated and tested on selected sites in the project area and simulations will be conducted to predict the overall effect of management systems on the transport of nitrate, phosphorus, and bacteria to Danube River. Once tested using this project data, this model will be applied to other landuse areas of Romania to predict the effect of agriculture on chemical loadings to Danube River and the Black Sea.

vii) Project will purchase one centrifuger and the state-of-the-art equipment for nitrate analyses to strengthen the existing capacity of EPA for analysis of soil and water samples as well as to support the monitoring work. Also, several other pieces of equipment would be bought to strengthen EPI and PHD laboratories in Calarasi. The project will coordinate this activity with other GEF projects in the Black Sea.

Frequency of Sampling: The frequency for collecting soil and water samples will depend on the weather and cropping pattern in the areas. A minimum of one water sample should be collected each month from each of the surface water monitoring stations (rivers, irrigation/drainage canal) piezometers, and drinking water wells). Water samples will be collected after every major rain storm of greater than 7.5 cm per day or of greater intensity for water quality analyses (the greater likelihood of transport of fertilizers, pesticides, soil and manure to surface water bodies will be with major rains and surface water must be sampled for agricultural and bacteria pollutants).

Quality Control and Quality Assurance The project will develop a quality control/quality assurance (QC/QA) operational manual to give detailed methodology on sample collection, transport, preservation, storage, and laboratory analytical procedures for chemical and bacteria analyses. Local consultant in coordination with the international consultant will prepare the first draft of this manual by November 30, 2000. In the April 2001 mission, it was agreed that a translated copy of the manual in Romanian will be given the EPI and PHD laboratories for making changes and a copy of the revised manual would be prepared by May 30, 2001. A translated copy of this revised manual in english will be sent to Ramesh Kanwar, International Consultant by June 15, 2001.

Data Analyses: Statistical methods must be developed to analyze and interpret soil and water quality data collected from rivers, drinking water wells, piezometers, and from demonstration study plots. Water quality data must be analyzed quarterly and reports be written and submitted to the International Environmental Consultant for evaluations

Training: It is recommended that one chemist from the EPA laboratory, who will be responsible for analytical analyses for soil and water be sent abroad for a short term training to update himself/herself on latest advances in the analytical procedures and new laboratory equipment. Also, one environmental engineer will be trained on the use of SWAT Computer simulation model and on QC/QA protocols required for various soil and water monitoring activities in this project.

Installation of Piezometers: It is frequently necessary and economical to install piezometers or groundwater wells for water quality monitoring. These wells/piezometers can also be used to collect data on saturated hydraulic conductivity of the aquifer media and conduct pumping tests. The wells and piezometers used throughout this project will be a 50 mm i.d. schedule

40 PVC pipe with a 0.25 - 0.5 mm width slot in the well screen. Slotted openings in the PVC screen will be comprised of horizontally cut 0.25 - 0.5 mm openings spaced 3.4 mm apart. Each 0.76 m length of PVC screen will be slotted for 0.61 m at the center of its length. The bottom sections of the screen will be capped and the top will be threaded into 1.2 m lengths of PVC standpipe of the same diameter. Holes for piezometer installations will be advanced using a hollow-stem auger. Each piezometer will be plugged with a sealed plug at the bottom and each section will be sealed with an O-ring and threaded. The annular space between the slotted PVC openings and the walls of the borehole will be filled with 40-60 mesh silica sand to 0.3 m above the top of the slotted openings. A 0.4 m layer of bentonite pellets will be place as a seal above the sand pack. The remaining annular space to the surface will be grouted with a cement-bentonite mixture. After installation of the wells and piezometers, caps and locking covers will be added. A deflection plate or a concrete pad will be installed just below the surface to prevent any direct movement of surface water along the edges of the pipe. Each piezometer casing will be encased in a metal pipe with a lock and key mechanism. This metal pipe will be embedded into the ground to a depth of about 0.3 m and sealed with concrete near the ground surface. The key of the lock for each piezometer will stay with the environmental monitoring engineer/specialist. All materials for piezometer construction will be purchased from the Romanian Government approved vendors. During the well installation cores will be taken to characterize the geologic structure and physical characteristics of the profile. Changes in lithology, color, strata, and carbonate structure will be recorded in the field notebook. **The exact location of piezometer installation will be selected after obtaining hydro-geology, topographic, and land use maps of the project area.** We plan to install 10 piezometers in the polder and another 10 in the terraced area of the project.

All piezometers will be developed immediately after installation. The best way to develop these piezometers/wells would be to purge them several times before use.

For groundwater monitoring, shallow piezometers (less than 7 m) and will be used to monitor the water table in the saturated zone. Other piezometers will range in depth from 8-20 m. and will be installed in accordance with the procedures for well installation. These wells will be located throughout the watershed and surrounding the experimental plots in selected villages to provide a measure of pesticides, nitrate, bacteria, and other parameters such as phosphorus at various levels within the saturated groundwater zone.

Shallow ground water wells/piezometers (less than 7 m in depth) will be sampled once a month. Deeper piezomers (> 7 m in depth) will be sampled once a month for water quality analyses. Before ground water sample is collected for analysis, entire water column in the piezometer will be pumped out one day before the sample is collected. Once the piezometer pipe is filled with fresh ground water from the saturated zone, water samples will be collected for analytical analyses. Piezometers will be sampled with contamination-free pumps. A zero contamination pump will be used to collect samples in 1-liter amber glass bottles. For bacteria and herbicide analyses, the water samples will be collected in sterile glass bottles.

E. Cost Analysis

Table 4 gives the estimated costs for various activities in the soil and water monitoring program in the Romania Agricultural Pollution Control Project.

Table 4. Romania APCP – Cost Table for Soil and Water Monitoring Program

Activity	unit	unit cost	year 1	year 2	year 3	year 4	year 5	Total
Piezometer	20 plus 56 for platfor ms	$600 $400 for manure platforms	$12,000 $22,400	-	-	-	-	$12,000 $22,400
Equipment								
Lachet AE	1	$35,000	$35,000	-	-	-	-	$35,000
Centrifuger	2	$5,000	$5,000	-	-	-	-	$10,000
Elec. Balance	2	$4,000	$4,000	-	-	-	-	$4,000
Soil Sampler	2	$1,000	$1,000	-	-	-	-	$1,000
Technical Asst								
International	1		$5,000	$5,000	$5,000	$5,000	$5,000	$25,0000
Local	1	$6,000/mo	$6,000	$6,000	$6,000	$6,000	$6,000	$30,000
Workshops	2	$1000	-	-	$1,000	-	$1,000	$2,000
Pumping Syst.	2	$1,000	$1,000	-	-	-	-	$1,000
Lab Analyses EPA and DPH (lump-sum)			$80,500	$80,500	$80,500	$80,500	$80,500	$302,000
Training (overseas)	4	$5,000	$10,000	$10,000	-	-	-	$20,000