Mapping a Survey for Soil Fertility in Tainal Watershed (Bazian plane) Sulaimaniyah Ecosystem Using Application of GIS

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Abstract

Soil fertility parameters (nitrogen, phosphorus, potassium, calcium, magnesium, sodium, chloride, calcium carbonate, organic matter) were determined in soil samples that taking from deep 0 – 30cm. In greenhouses sowed with different vegetable cucumber, tomato, pepper, eggplant) in 24 villages of Tainal watersheds (Bazian city-As Sulaimaniyah). In the present study, a new technology of ArcGIS 10.1 was used for mapping. The results obtained from a survey area had 12 km^2 (N 35.5731; E 45.1798) for soil fertility. Results show that farmers did not fertile soil based on soil analysis except some farmers in Bagajani sites (N 0.22%, P 92.6 ppm, K 0.038 mEq^{-L}, O.M 2.85%, EC.0.23 $dS.m^{-1}$).In the same area (N: 35.750, E:45.354), soil in villages (Shuwankara, Zyeka , Gawani) have the heights ratio in nitrogen comparing to others (0.0380% , 0.325%) . According to the results, all the greenhouses soil samples are low in fertility and need to add appropriate fertilizers. All the soils in other villages' have the same problem accept one site they were using organic matter before sowing by two months. The study revealed that 82% of the samples were under critical threshold value for soil fertility.

Keywords: Soil fertility survey, GIS, Bazian, plant nutrient elements.

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Introduction:

According to Ulrike *et al.,* (22). Food production should increase by 40% by 2025, in order to meet the needs of a population that is rising at a rate of 33%. Intense cropping, inconsistent fertilizer use, and unreliable and low-quality irrigation water are all necessary elements of the region for meeting these food production targets for wealthy people, all of which have resulted in less productive soils. However, no particular spatial information on the status of micro and macronutrients in the so-called "food desert" exists at this time.

Although soil fertility is a significant limitation to agricultural production in developing countries, GIS-derived variables are included in the household decision model. Their use also allows for the prediction of geographical uptake based on parameter estimates.

Akhter *et al.,* (2) create detailed maps of the region's soil fertility and link the state of fertility to agricultural practices. According to Omamo *et al.,* (15). A geographic information system (GIS) is a critical tool for integrating various types of spatial data to derive useful information, such as agro-climatic zone, land use, and soil management.

It must be carried out to be aggressively planted with high-producing crops, according to Staal *et al.,* (18). Composite soil samples are often obtained in the fields after soil testing with no geographic reference. Further monitoring of soil accessible nutrients status using GPS will aid in developing site-specific balanced fertilizer recommendations and understanding the state of soil fertility regionally and temporally, and such soil testing findings are not acceptable for site-specific recommendations (16). Exchange capacity: Soil fertility is linked to (exchange capacity), or the ratio of colloidal particles, particularly humic compounds, that make up the adsorption compound. Plants' mineral nutrition improves as their exchange capacity is increased. Provides a favourable environment for plant root development (6, 1 and 13) Fertility. The mineral cation proportion in the soil: The cations required for plant nutrition must be accessible in a balanced manner in the soil. Organic matter: Because it enhances the physical and chemical characteristics of the soil, the quantity of organic matter in the soil plays an important role in soil fertility (9). Soil Structure: The ability of roots to penetrate the soil in search of water and minerals that nourish the plant is dependent on soil structure. The texture of the soil: It's the soil's mechanical structure, or the total of the basic constituents that make up the soil, such as clay, silt, fine sand, coarse sand, and occasionally gravel. Depth of the soil: The higher the depth of the soil, the bigger the area over which the roots may grow, allowing plants to receive more nutrients. The depth of the soil can occasionally compensate for nitrogen deficiency (11). Soil Structure: The ability of roots to penetrate the soil in search of water and minerals that will nourish the plant is dependent on soil structure. The texture of the soil It's the soil's mechanical structure, or the total of the basic constituents that make up the soil, such as clay, silt, fine sand, coarse sand, and gravel. Depth of soil the deeper the soil, the larger the area over which the roots may grow, increasing numerous of nutrients received by the plants. The depth of the soil can compensate for nitrogen deficiency in some cases (20).

Material and Method

Bazian is a large and important area located in Kurdistan, northeast of Iraq, 20 kilometers southwest of Sulaimaniyah governorate, 35N latitude and 45 E longitudes, with at least 4000 greenhouses. The sea surface level reaches it (837m – 847m). Also, in the BASARA Basin, which is in the high folded zone, is the Bazian Plain, which is a large plain with a slightly sloped surface. It has six watersheds and fourteen micro-catchments'- Streamflow: Basara Basin has many sprinkameezezes. Basara Basin has pa erenniamainstream, which consists of the combination of two great streams which are The ilia stream and the Chami Tainal stream (4).

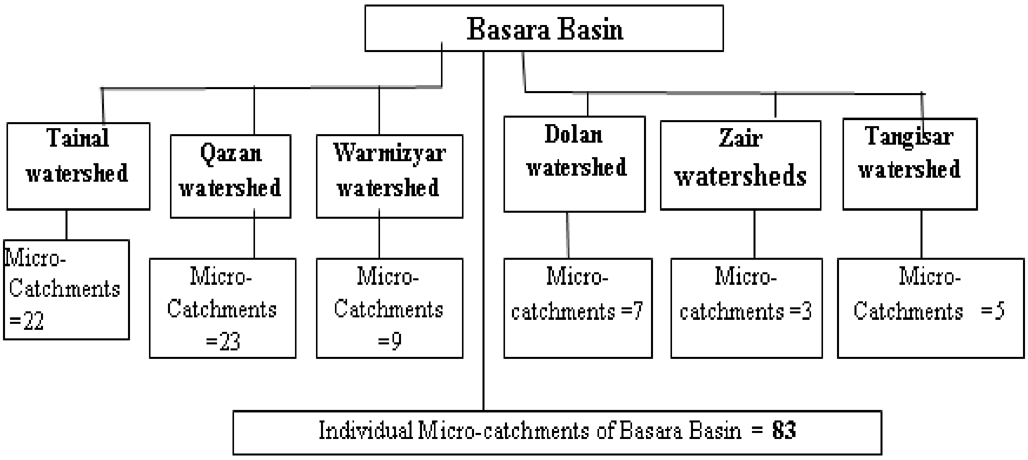

Fig. 1, Basara Basin

Table1. Soil analysis for the samples that taken from the study area

Village name	E.C. ds.m	PH	N $meq.l^{-1}$	Available P $meq.l^{-1}$	Soluble K^{+} $meq.l^{-1}$	Soluble Na^{+} $meq.l^{-1}$	Soluble Ca^{+2} $meq.l^{-1}$	soluble Mg^{+2} $meq.l^{-1}$	Cl^{-} $meq.l^{-1}$	$CaCo_3$ $meq.l^{-1}$	HCO_3 $meq.l^{-1}$
Bagajani	0.59	7.57	750	0.13	0.38	0.13	2.35	2.75	0.41	2840	3.7
Mewk	0.70	7.65	321	0.07	0.065	0.11	0.97	1.35	0.265	2000	1.64
Bagajani	0.235	7.64	785	0.95	0.038	0.77	5	6.6	1.55	1800	1.8
Koyik	0.23	7.50	339	0.07	0.011	0.075	1.15	1.65	0.37	1460	1.7
Kani big	0.235	8.45	785	0.12	0.011	0.22	3	1.95	0.55	1380	1.8
Shuwankara	0.41	7.40	1357	0.11	0.015	0.23	3.2	1.35	0.38	1500	3.2
Tui awlia	0.38	7.30	642	0.15	0.022	0.2	2.8	1.45	0.35	980	0.8
Qushqaya	0.29	8.20	303	0.08	0.018	0.053	1.4	0.9	0.18	1500	1.8
Ali Bzaw	0.45	7.45	410	0.09	0.027	0.145	1.45	0.85	0.375	1620	2.95
Ali Bzaw	0.29	7.70	535	0.04	0.055	0.19	1.1	1.35	0.25	1480	1.35
Kani Penjsharnma	0.42	8.45	714	0.26	0.042	0.12	1.25	0.6	0.55	1260	1.7
Kani Shaya	0.34	7.85	1035	0.08	0.032	0.079	3.35	1.7	0.315	1160	1.25

Kani Shaya	0.43	8.15	339	0.075	0.032	0.07	1.4	1	0.25	960	0.9
Halay Sarchawa	0.36	7.15	785	0.11	0.038	0.13	1.5	1.7	0.35	1080	0.7
Halay Sarchawa	0.45	7.40	392	0.06	0.0175	0.775	1.8	1.25	0.15	1260	0.5
Mahmudia	0.37	8.6	410	0.08	0.019	0.16	1.7	1.65	0.29	960	0.8
Ziyeka	0.36	7.05	428	0.12	0.038	0.11	2.7	1.85	0.19	1620	2.45
Ziyeka	0.30	7.42	1160	0.14	0.032	0.18	2.55	2.1	0.35	1080	0.6
Warmizyar	0.44	8.15	785	0.11	0.04	0.086	2.85	3.4	0.45	1340	2.6
Warmizyar	0.049	7.95	892	0.12	0.04	0.14	3.15	3.8	0.42	1440	1.4
Gawani	0.35	7.70	250	0.08	0.0125	0.115	0.745	1.2	0.325	1600	1.5
Gawani	0.255	6.80	1160	0.21	0.018	0.28	4.1	2.6	0.51	1340	0.94
Gawani	0.445	7.75	500	0.14	0.016	0.088	2.65	1.45	0.44	1400	1.2
Latif awa	0.47	8.05	1107	0.14	0.027	0.11	3.2	2.1	0.32	880	0.6
Warmizyar	0.44	8.15	785	0.12	0.04	0.086	2.85	3.4	0.45	1340	2.6
Warmizyar	0.049	7.95	892	0.13	0.04	0.14	3.15	3.8	0.42	1440	1.4
Gawani	0.35	7.70	250	0.08	0.0125	0.115	0.745	1.2	0.325	1600	1.5
Gawani	0.445	7.75	500	0.14	0.016	0.088	2.65	1.45	0.44	1400	1.2
Latif awa	0.47	8.05	1107	0.12	0.027	0.11	3.2	2.1	0.32	880	0.6

Using GIS applications to produce GIS maps to show the distributions soils fertility in the area, this area contains many villages, we took the samples from 24 villages that contain at least 2000 greenhouse in 10km2 area, Soil Samples taken from deep 20 – 30cm for fertility analysis.

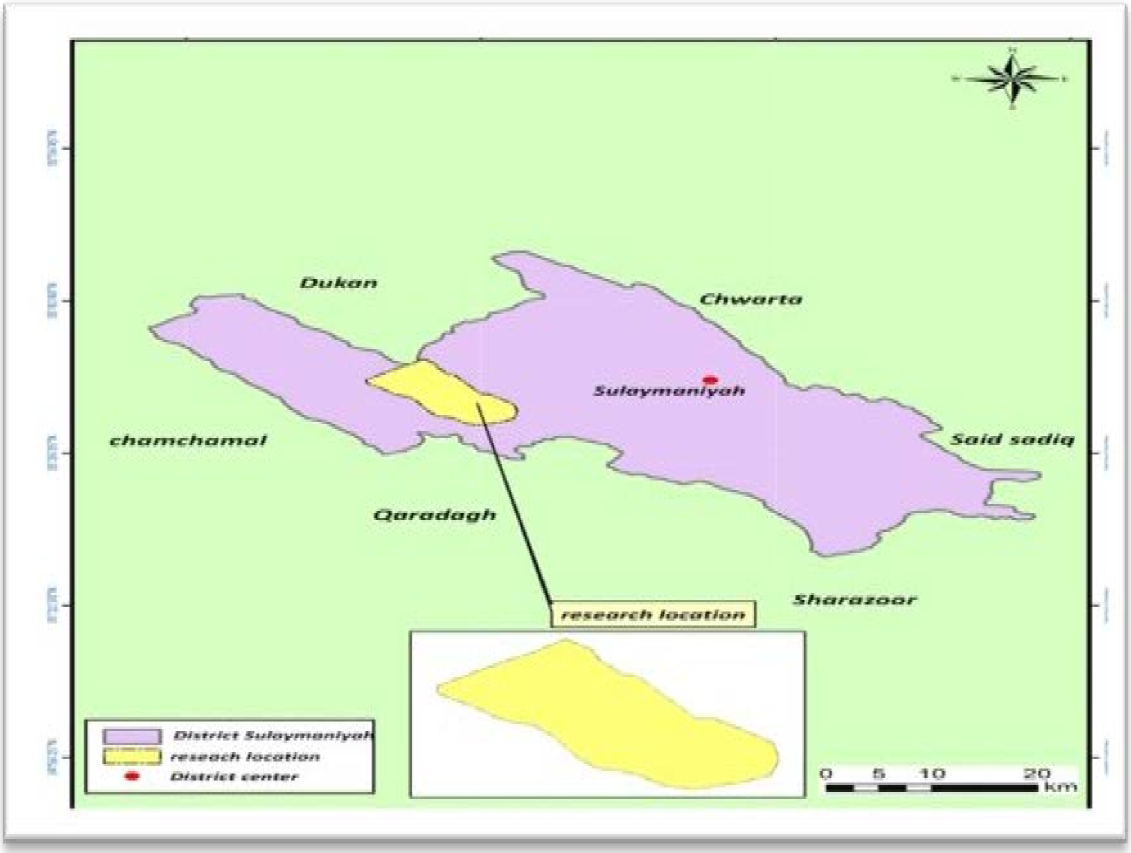

Fig. 2, Location of the survey depending on table 3, and ArcGIS 10.1

Table 2. Plant analysis procedures

Analysis kind	Procedure	Source
N%	Kjeldahl	Soil and plant analysis (Laboratory index) by John Ryan George Stephen international Center for agriculture Research in the dry areas. And Abdul Rashid National Center for Agriculture research Islamabad, Pakistan
Available P	Olsen and Sommers, 1982	
Soluble k	Richards, 1954	
Soluble Na	Richards, 1954	
Soluble Ca	Richards, 1954	
Soluble Mg	Richards, 1954	
CL	Richards, 19544	
O.M. %	Walkley, 1974; FAW, 1974	
$CaCo_3$ %	FAW, 1974	
HCO_3	Richards, 1954	
CO3	Richards, 1954	

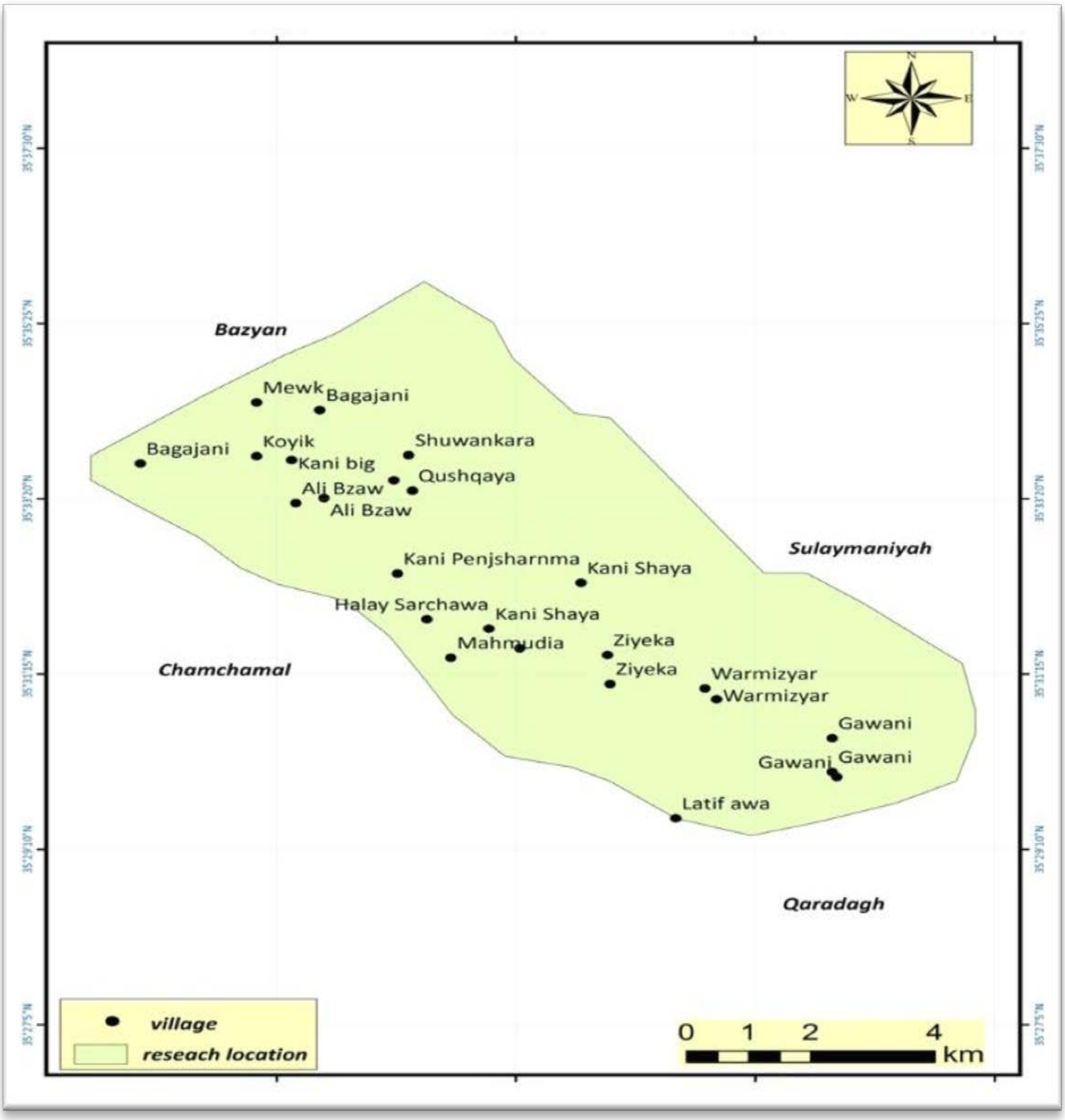

Fig. 3, Villages coordinate in Tainal watershed depending on table 3, and ArcGIS 10.1program

Results and Discussions

Making Gis map for parameters that selected before to explain the distribution in the villages

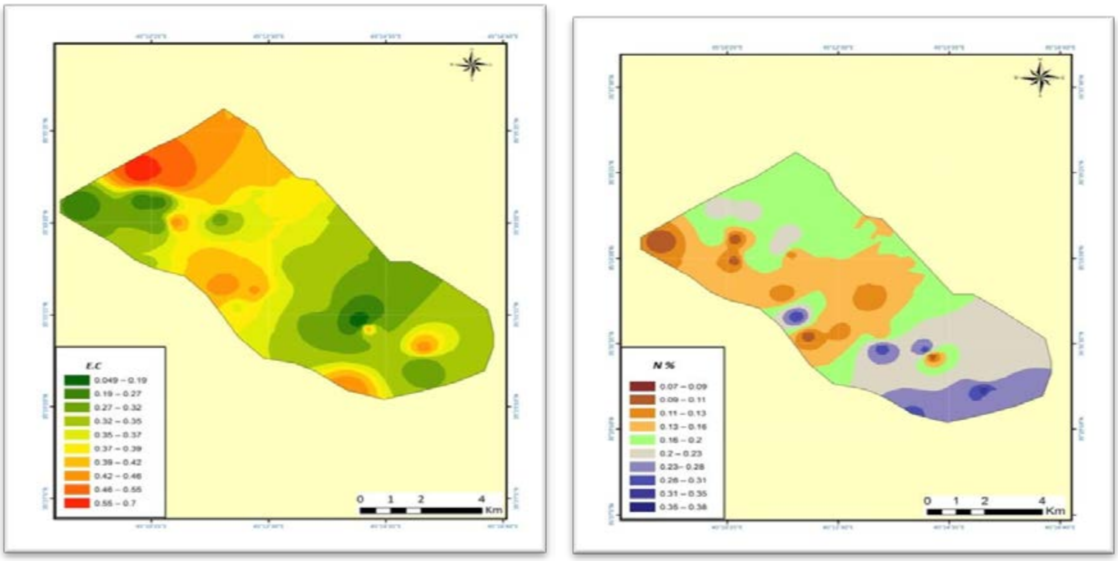

Fig. 4, Depend on Table 3, ArcGIS 10.1 Survey for soil fertility showed A Spatial Distribution of A: EC, B: N% for the study area

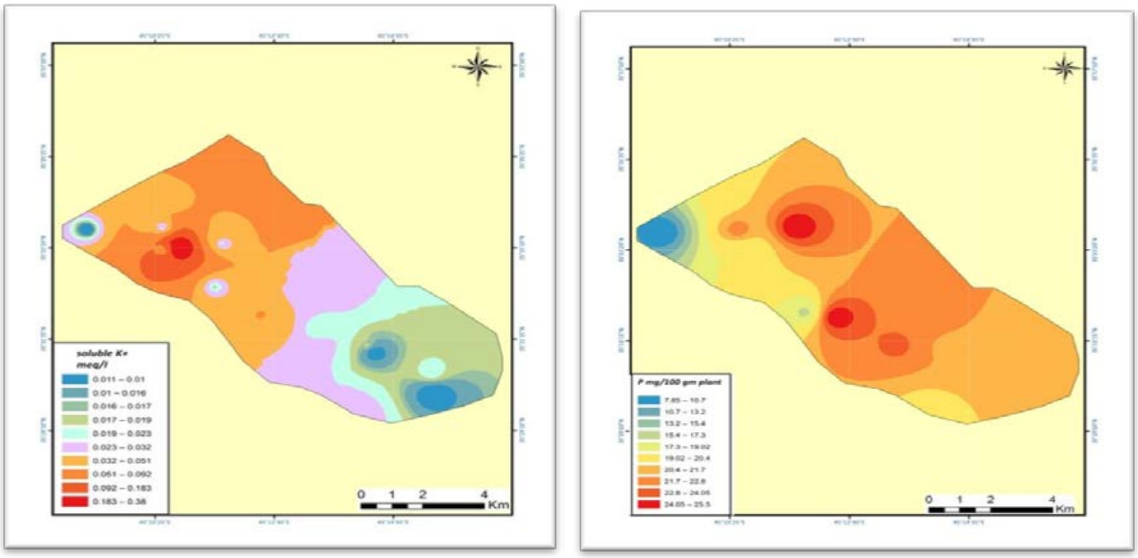

Fig. 5, Depend on Table 3, ArcGIS 10.1 Survey for soil fertility showed A Spatial distribution of A: K, B: available (p) for the study area

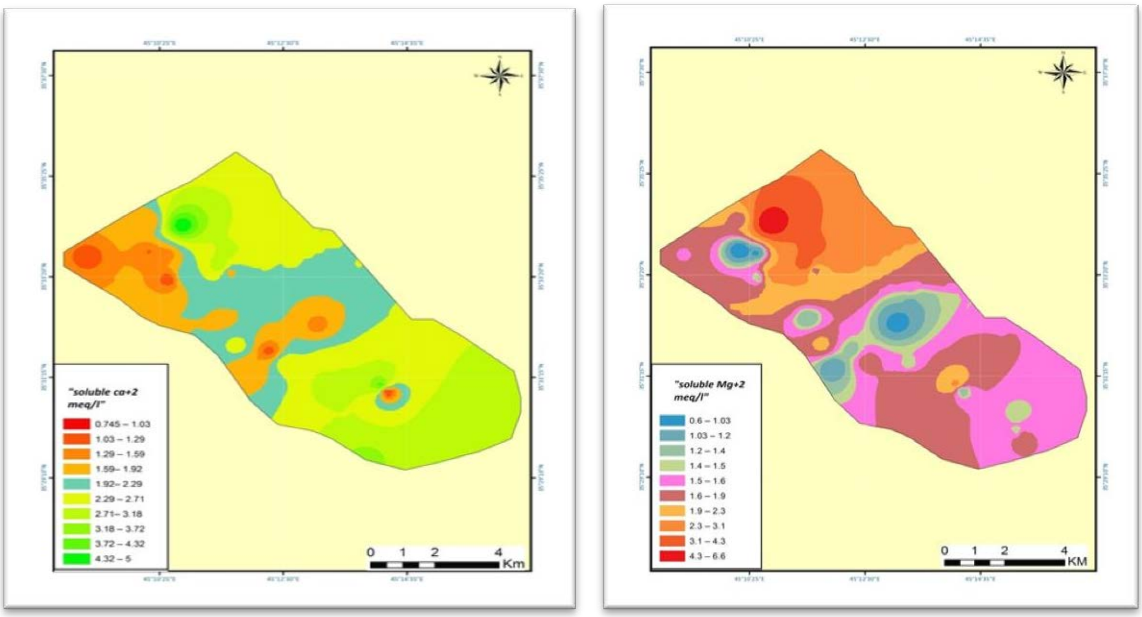

Fig. 6, Depend on Table 3, ArcGIS 10.1 Survey for soil fertility showed

A Spatial distribution of A: Ca, B: Mg for the study area

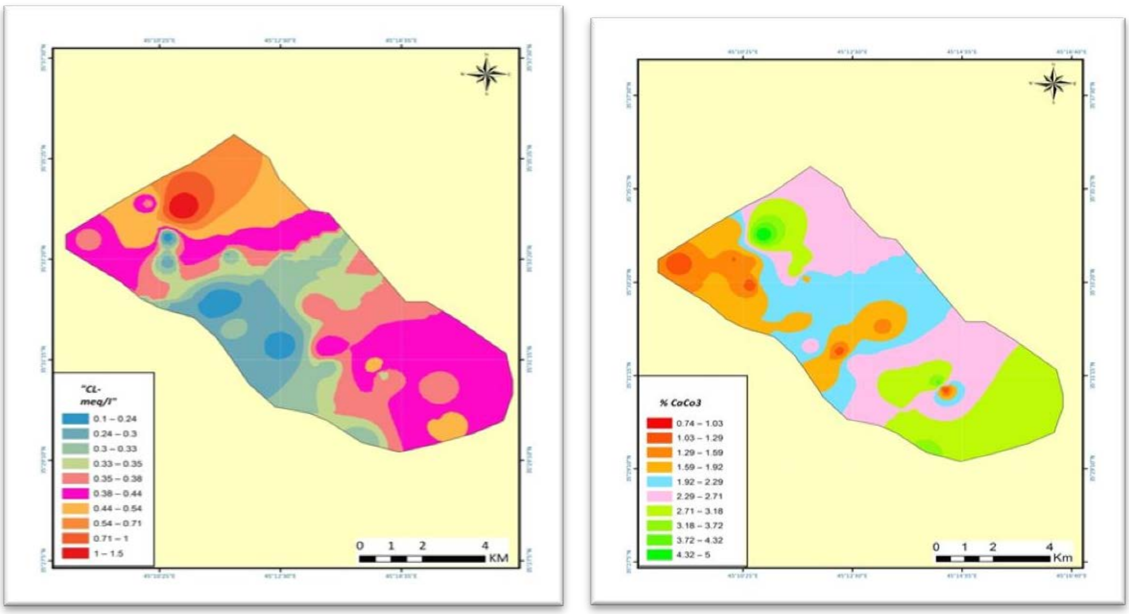

Fig. 7, Depend on Table 3, ArcGIS 10.1 Survey for soil fertility showed

A Spatial distribution of A: Cl , B: CaCo3 for the study area

Improvement of plant health is the ultimate goal of ecosystem management. Even if adding organic matter to soil may not prevent soil pests, it can increase crop yields, which is the primary goal for a farmer (10).

From Fig. 4, A and Table 3 there is a difference between the 24 sits that we study (Mewk 0.70 and Bagajani 0.59, Latif awa 0.47, Haley Sarchawa 0.45 $ds.m^{-1}$) E.C. was high that return to using a high quantity of chemical fertilizer as reported from. Aimrun *et al*. (3).

Farmers in this area use green manure and organic fertilizer on a regular basis, and when these rich nutrients break down, salts and ions in the soil's liquid phase rise. Such changes have an impact on soil EC, which is influenced by a variety of soil fertility properties, including pH, P, K, Mg, Ca, OM, CEC, and the concentrations of other soluble salts (17).

EC-soil property interactions are easily identified because the amplitude of the reactions governing soil EC levels is complicated and dynamic. It's crucial to look into the changes in EC in soils treated with various wastes; EC is defined by Bronson *et al.,* (5). As the total amount of salts and ions in the soil solution, whose levels are influenced by the kind, content, and amount of waste that is delivered to the soil?

EC could be used as a supplement to other soil fertility indicators. In this location, soil EC varies, although it had altered (from 0.23 to 0.7 $ds.m^{-1}$) as a result of the addition of organic matter, primarily when the soil was incubated with chicken and animal manures and other compost. The soil EC values found in this investigation, regardless of the extent of the soil electrical conductivity change, were below the range considered safe for plant growth, according to Sudduth *et al*., (21).

Our farmers depend on three sources of Nitrogen; mineralization of organic microbial decomposition of animal and plant residues in the soil gives mineral nitrogen, nitrate and ammonium, forms of nitrogen that plants can absorb from the solution of soil. Soil organic matter also is an essential source for N.

Biological fixation of atmospheric N2 This N supply is unavailable to plants unless it is catalytically converted to mineral N (NH^{+4}) by extremely specific bacteria, therefore plants in greenhouses do not receive it directly.

Some farmers employ crop residues that aren't removed from the greenhouse at harvest, leading to disease carryover, root exudates, and more crop residues. The reasons why N fertilizer application boosted soil organic matter were the following (7).

From Fig. 4, B and Table3 (Shwankara 0.38, Ziyka 0.32, Gawani 0.32, Kani shaya 0.29 %) the law ratio of N in most of the area return to the lowest of adding compare with taking from soils Bonner and Varner (19) reported this return to not use a scientific program depending on soil analysis, generally, most of the soils in this area is under the moderate range (< 0.2 %)

Because of using plant and animal residue and chemical and organic fertilizer so our farmers have a good source for Phosphorus, ratios in soils in these areas were in higher in (Bagajani 92.64 $mg.kg^{-1}$, Kani penjsharma 25.9, Gawani 21) this high quantity in the soil as in Table 3

$H2PO^{-4}$ and HPO^{-4} are two types of soluble P, with the proportions varying depending on the ph. They are in equal quantities at pH 7.2. The ratio of $H2PO^{-4}$ to HPO^{-4} is 10:1 at pH 6.2, and 1:10 at pH 8.2. Philippe et al., (19).

(Fig. 5, A Table 3) In (Kani Shaya and Qushqaya) Phosphorus ratio was the highs (25.5mg, 25.3mg) these ratios are low compared to plant needs as, Lenaldo *et al.*, (12) reported.

Potassium is the "universal cation" like they say in the biological systems, in all pH levels have no toxic, even at soil and plant levels, farmers like to use K in their crops they depend on chemical fertilizer at first to supply them with K and also an organic source.

(Fig. 5, A Table3) In (Mewk 0.065, Ali Bzaw 0.055, Kani Penjsharnma 0.042 $m.eq.l^{-1}$) we have the high value of K, but it is a low value for K in the soil in this area depending on Najera et al., (21).

(Fig. 6 and Table 3) farmers in this area use Ca not widely, in (Bagajani 5.0 meq/l. and Gawani 4.1, Latif awa $3.3m.eq.l^{-1}$) these are the highs in this area but Najera *et al*. (14) said soil should content in medium average ($4.1\text{-}8mol.kg^{-1}$) but in the other places the Ca ratio is lower so the need to use some calcium source as a fertilizer.

When we visited other greenhouses, we noticed yellow fractures between the veins and around the leaf edges instead of Mg deficiency. Purple, brown, and red are among the other colors that show. The older leaves are the first to suffer, and some of them die as a result of their lack of treatment.

Farmers must understand the need to apply a yearly mulch of compost as a long-term solution. This will conserve moisture while also providing enough magnesium to the soil to keep the plants healthy.

After heavy irrigation, high $CaCO_3$ causes rhizospheric alkalinity and nutrient imbalance, resulting in reduced root growth and poor plant development. Soil farmers in (Upper Bagajani 14.2%, Mewk 10%, Lower Bagajani 9%, Ziyeka 8.1 percent, Ali Bzaw 8.1 percent) (Fig.7, B Table 3) have the highest it ratio in this area. The major component of limestone, calcium carbonate, is frequently utilized to reduce soil acidity and provide calcium (Ca) for plant nourishment. The term "lime" can apply to a variety of things, but it most commonly refers to pulverized limestone in agricultural applications.

The occurrence of excessive CaCO3 (15-40%), according to FAO (8) is not a significant issue in our reign soils, though it is close in some spots. However, in a greenhouse, the temperature will rise in the summer, causing evaporation from the top and replacement from the water table below. When groundwater is taken up, it frequently contains considerable volumes of dissolved CaCO3, which is deposited inside the soil-body upon evaporation, resulting in a buildup of this substance.

Conclusions

Although the concept of sustainability has gained widespread acceptance, the dominant healthy agricultural philosophy views high yields and decreased environmental consequences as incompatible.

Given the economic limits imposed on

production-oriented farming systems, nutritional requirements in agriculture will be difficult to meet. Because nutrients are crucial in agro ecosystems, conscious control of fundamental ecosystem processes can help to prevent environmental losses. Under this concept, the goal of survey fertility would be to balance nutrient budgets as much as feasible while maintaining these reservoirs.

Breeding for cultivars and their associated microbes that do not require surplus additions of soluble nutrients should be stressed in conjunction with agroecosystem activities that expand the ecosystem's capacity in ways that lead to reduced needs for surplus additions. Understanding the need to employ natural fertilizer (resources) to keep soils fertile and sustain a healthy agroecosystem Soil fertility management can have a variety of consequences on plant quality, which can alter the abundance of nematodes or other insects as well as the extent of herbivore damage. The distribution of mineral supplements in crop plants has the potential to affect the growth, survival, and reproduction of insects that feed on these plants.

Agroecosystem management based on organic soil fertility methods can offer secondary element supplies from time to time, resulting in a healthy agroecosystem. Traditional farming techniques, which rely primarily on artificial supplies of N, P, and K, are deficient. In addition to nutrient concentrations, optimal fertilization, which offers a balanced balance of components, can boost insect resistance.

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