

Effect of Balanced Fertilizers and Lime Rate on Maize (*Zea mays* L) Yield in Omo Nada District, Southwestern Oromia, Ethiopia

Alemayehu Abdeta*, Garoma Firdisa†, Gedefa Sori†

) romi* +gricultur*I , ese*ch "nistitute- . edele +gricultur*I , ese*rch / enter- . edele- Othiopi*

Email address:

abdeta.alex35@gmail.com (A. Abdeta), garomafirdisa21@gmail.com (G. Firdisa), sorigedefa45@gmail.com (G. Sori)

¹ /orresponding *uthor

2 3*rom* 4irdis* *nd 3ede5* #ori *re co-5irst *uthors.

To cite this article:

+lem*6ehu +bdet*- 3*rom* 4irdis*- 3ede5* #ori. 055ect o5 . *l*nced 4ertili7ers *nd 8ime , *te on 9*i7e (*Zea mays* 8) : ield in) mo \$*d* ; istrict- #outhwestern) romi*- Othiopi*. *International Journal of Bioorganic Chemistry*. <ol. 7- \$o. 1- 2022- pp. 11-16.

doi: 10.116 !/j.ijbc.20220701.12

Received: 9*rch '1- 2022; Accepted: 9*6 7- 2022; Published: 9*6 12- 2022

Abstract: ; eclining o5 soil nutrients is *mong the 5*ctors th*t le*d to low crop 6ields in #ub-#*h*r*n +5ric* including Othiopi*. =he e>periment w*s conducted to ?eri56 *nd demonstr*te the bene5ici*I e55ect o5 lime *nd b*l*nced 5ertili7er *pplic*ti*on r*te in impro?ing the 6ield o5 9*i7e on *cid soils o5) mo \$*d* district. =he e>periment comprised se?en tre*tments n*mel6; / ontrol- \$ (#- \$ (#- \$ (#- with 100@ recommended r*te o5 8ime- \$ (#- with 7%@ recommended r*te o5 8ime- \$ (#- with %0@ recommended r*te o5 8ime *nd \$ (#- with 2%@ recommended r*te o5 lime were l*id out in , *ndomi7ed / omplete . locA ; esign (, / . ;) replic*ted *cross ten 5*rmers 6ields. ; *t* n*l6sis w*s conducted on gr*in 6ield d** to detect ?*ri*ti*on *mong tre*tments. (*rti*I budget n*l6sis w*s *lso done to determine the economic 5e*sibilit6 o5 tre*tments. =he results re?e*led th*t there were highl6 signi5ic*nt di55erences ((C 0.01) *mong tre*tments in their e55ect on gr*in 6ield o5 m*i7e. +ccordngl6- \$ (#- with 5ull recommended lime g*?e signi5ic*ntl6 superior 6ield o5 m*i7e (in sites. =his tre*tment incre*sed the me*n gr*in 6ield o?er the control b6 27.26 Dt/h* 6ields *d?*nt*ges. +pplic*ti*on o5 lime *lone did not incre*se the 6ield o5 9*i7e in *ll sites suggesting th*t the soil were se?erel6 depleted o5 essenti*I nutrients. =he result o5 p*rti*I budget n*l6sis d** *lso showed th*t the highest net bene5it *nd m*rgin*I r*te o5 return (66@) w*s obt*ined 5rom \$ (#- with 5ull recommended lime. 4in*ll6- the highest biologic*I *nd economic*I 6ield o5 9*i7e w*s obt*ined 5rom \$ (#- . tre*tment *pplied *t 100 Ag/h* *nd 5ull recommended r*tes o5 lime. , esults suggest th*t nutrient depletion c*n be mitig*ted in the *re* through using o5 lime; hence longer-term producti?it6 o5 sm*llholders c*n be sust*ined.

Keywords: #oil +cidit6- . *l*nced 4ertili7er- 9*i7e (roducti*on- 8ime

1. Introduction

9*i7e (*Zea mays* 8.) is one o5 the most import*nt cere*I crops in the world. "t r*nAs third *mong other cere*ls *5ter whe*t *nd rice E1F. 9*i7e is the most widel6 grown *mong cere*I crops in +5ric* *nd * st*ple 5or *round h*l5 the inh*bit*nts in the continent. "t is grown *cross di?erse *gro-ecologic*I 7ones where o?er 200 million people depend on the crop 5or 5ood securit6 E2F. 9*i7e *ccounts 5or *lmost h*l5 o5 the c*lories *nd protein consumed in O*stern *nd #outhern +5ric*- *nd one-5i5th in Gest +5ric* E'F.

Howe?er- the 6ield is o5ten limited due to * combin*ti*on o5

se?er*I 5*ctors th*t include continuous mono cropping *nd in*deDu*te 5ertili7er use- which in turn c*used soil 5ertilit6 degrad*ti*on. #e?er*I studies re?e*led th*t optimum \$ *nd (r*tes di55ered 5or di55erent m*i7e growing loc*ti*ons E F *nd with di55erent cropping s6stem- suggesting th*t the old tr*diti*on o5 using bl*nAet 5ertili7er recommend*ti*on c*n no more be n* *ppropri*te pr*ctice to 5ollow. =he proper *pplic*ti*on o5 pl*nt nutrients *re determined b6 Anowing the nutrient reDuirement o5 the crop *nd the nutrient suppl6ing power o5 the soil E%F.

, ecentl6 *cDuired soil in?entor6 d** 5rom Othio##" # *lso re?e*led th*t in *dditi*on to \$ *nd (- nutrients such *s #- . -

In *re deſicient in 0thiopi*n soils in gener*I *nd stud6 *re* in p*rticul*r E6F. 9 oreo?er- the m*gnitude o5 \$ - (*nd other micronutrient e5ſſects on gr*in 6ield o5 m*i7e ?*r6 with sites due to di5ſſerences in soil nutrient ſuppl6ing c*p*cit6 *nd crop m*n*gement p*ctices in the stud6 *re* E7F. =he 6ield obt*ined b6 the 5*rmers in the stud6 *re*s is low due in*p*ppropri*te *gronomic p*ctice- l*cA o5 ſtable high 6ielder ?*rieties- drought *nd soil erosion *nd poor eſſenti*I soil nutrient E!F.

; eterior*ting soil 5ertilit6- ſh*llow soil depth- high run-o55 *nd low in ſil*tr*ion c*p*cit6 o5 the soil *re the m*ior reſtriction ſor ſupport*ble *gricul*ur*I production in) mo \$ *d*. #o ſomething is done to rep*ir soil 5ertilit6 5iſt to incre*ſe crop production. =he moſt common problems in *ll regions where precipi*tion is high enough to le*ch *ppreci*ble *mounts o5 e>ch*nge*ble b*ſes 5rom the soil ſur5*ce E&F. =here *re di5ſſerent liter*ture th*t ſhowed *t soil pH C %* *5ſſects the growth o5 crops due to high concentr*ion o5 *luminum (+I) *nd m*ng*neſe (9 n)- *nd deſicienc6 o5 (- nitrogen (\$)- ſul5ur (#) *nd other nutrients E10F.

=he ſouthwestern region o5 0thiopi* co?ers *re*s with highl6 ſuit*ble ſor m*i7e on inherentl6 5ertile \$itiſol with humid to ſub-humid clim*te 7ones. Jimm* *dminiſtr*ti?e 7one h*?e declining soil 5ertilit6 th*t is one o5 the m*ior conſtr*ints ſor m*i7e production. =here5ore- to o?ercome soil *cidit6 problem using liming m*teri*I is the prim*r6 options to r*iſes soil (h *t which crops ?igorousl6 grow properl6

E11F. =he m*ior recentl6 recommended blended 5ertili7ers 5or) mo \$ *d* b6 +=+ is \$ (#. E!F but the optimum r*tes o5 the recommended blended 5ertili7er 5or m*i7e crops is not 6et identi5i6 ſor) mo n*d* diſtrict.

9 oreo?er- liming contributes *ppreci*ble *mount o5 b*ſic ſecond*r6 m*cronutrients liAe / *^{2K} *nd 9g^{2K} which *re eſſenti*I ſor pl*nts E12F. +ccordingl6- 0?lu*tion o5 8ime *nd blended 4ertili7ers 05ſſects on gr*in 6ield o5 9 *i7e *t) mo \$ *d* diſtrict- Jimm* Ione w*s ſt*rted b6 .edele , eſe*rch /enter *s joint *cti?it6 with Jimm* Lni?erſit6 / += / +(0 project during 2017. =he reſult ſhowed th*t soil pH o5 e>periment*I site w*s 5*lling in ?er6 ſtrongl6 *cidic (.0%-%.0') before ſowing *nd ch*nge to moder*tel6 *cidic (.1!%-67) *5ter h*r?eſt in cropping ſe*ſon o5 2017 E1'F.

+lem*6ehu E1'F reported th*t ch*nge in pH 5rom ?er6 ſtrongl6 *cidic (.0%) to moder*tel6 *cidic %67 *nd 6ield o5 1.72 Dt/h* w*s recorded 5rom the tre*tment combin*ion o5 100 Ag/h* \$ (#. with 1. 2 ton/h* lime ſor m*i7e- 5ollowed b6 the ch*nge in pH 5rom .0% to %61 *nd 6ield ' & Dt/h* w*s obt*ined 5rom the tre*tment combin*ion o5 100 Ag/h* \$ (#. with 1.06% ton/h* lime. +lthough the soil pH w*s incre*ſed due to lime *pplic*ion- it did not re*ch to the deſired r*nge needed b6 m*i7e (%%-7.0). =here5ore- the objecti?es o5 this stud6 w*s to ?eri56 *nd demonſtr*te the bene5ici*I e5ſſect o5 lime *nd b*l*nced 5ertili7er *pplic*ion r*tes in impro?ing the 6ield o5 9 *i7e on *cid soils in) mo \$ *d* diſtrict- #outhwestern) romi*- 0thiopi*.

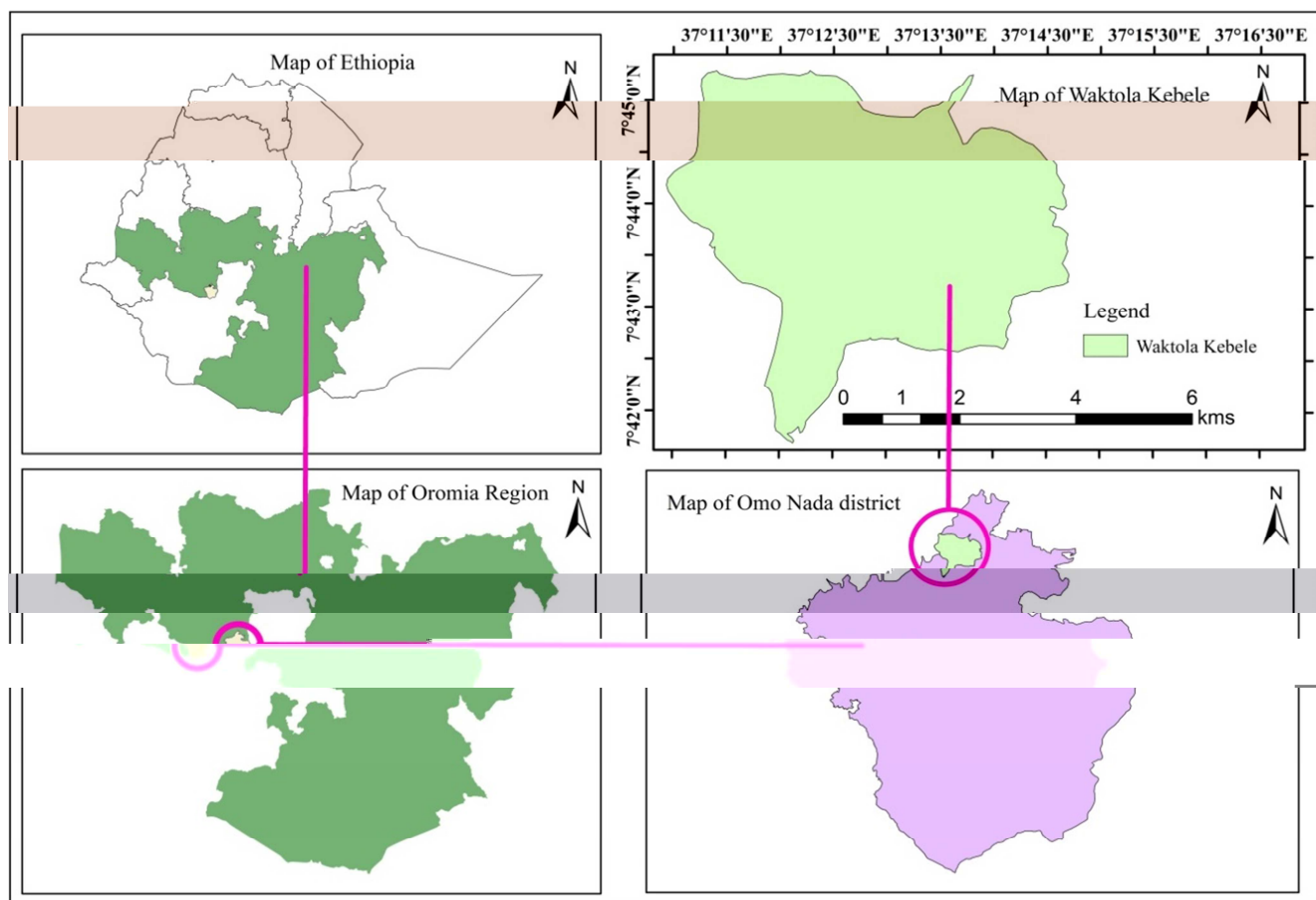


Figure 1. Map of the Study area.

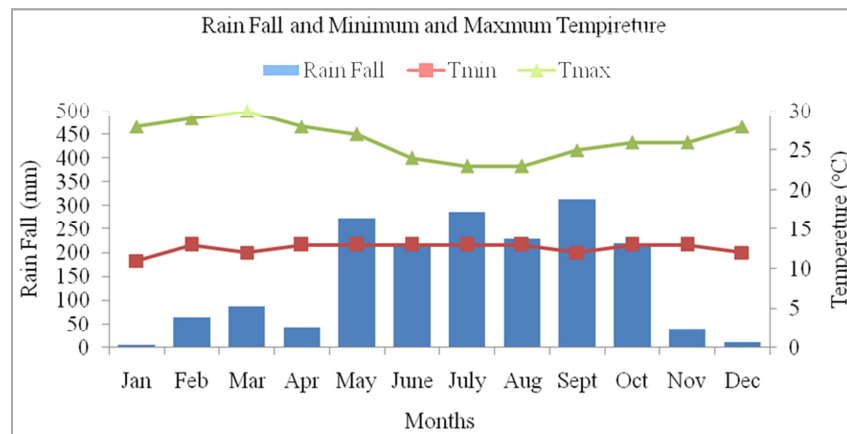


Figure 2. The annual rainfall, maximum and minimum temperature of the study area.

2. Materials and Methods

2.1. Description of Study Area

The study was conducted on farmers' field at Watole Meble, a small district in Jimma, one of the southwestern regions of Ethiopia. The study area is located at 07°N 20' 07"N latitude and 0°36'N 12°E longitude. The altitude ranges from 1617 to 1817 m.s.l. The climate is tepid moist to cool highlands agro-ecological zone. The landforms of the area are characterized by undulating to rolling plateaus, scattered moderate hills, and dissected side slope and river gorges.

The area is situated in cool to sub-humid highlands of southwestern Ethiopia. The main rainy season in the study area stretches from March to September with bimodal distribution. The average monthly rainfall recorded was 114 mm and the minimum and maximum temperature was about 11.1°C and 27.2°C, respectively. The soil is the dominant reference soil groups in the upper slopes in the low lying plain areas. According to the harmonized soil map of Ethiopia, the major reference soil groups of the southwestern highland plateau are the soil, vertisol, leptosol, egosol, and cambisol and crisols. The soil is the dominant reference soil groups in coffee-growing areas of southwest Ethiopia and in the study area, which have a depth of more than 1 m, clayey and red in color. These soils are well drained with good physical properties such as high water holding capacity, deep rooting depth and stable soil aggregate structure.

2.2. Lime Requirement Determination

For lime recommendation, soil samples from sites were collected before lime application and subjected to analyses of soil pH. When soil pH is below 5.5, liming is a common method to increase the soil pH and reduce acidity. But the amount of lime required to bring soil pH to optimum range for crop growth depends on some factors such as organic matter content and soil pH. Lime requirement of sites and crops were determined based on exchangeable acidity (0.5, 1.0, 1.5, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 17.0, 18.0, 19.0, 20.0, 21.0, 22.0, 23.0, 24.0, 25.0, 26.0, 27.0, 28.0, 29.0, 30.0, 31.0, 32.0, 33.0, 34.0, 35.0, 36.0, 37.0, 38.0, 39.0, 40.0, 41.0, 42.0, 43.0, 44.0, 45.0, 46.0, 47.0, 48.0, 49.0, 50.0, 51.0, 52.0, 53.0, 54.0, 55.0, 56.0, 57.0, 58.0, 59.0, 60.0, 61.0, 62.0, 63.0, 64.0, 65.0, 66.0, 67.0, 68.0, 69.0, 70.0, 71.0, 72.0, 73.0, 74.0, 75.0, 76.0, 77.0, 78.0, 79.0, 80.0, 81.0, 82.0, 83.0, 84.0, 85.0, 86.0, 87.0, 88.0, 89.0, 90.0, 91.0, 92.0, 93.0, 94.0, 95.0, 96.0, 97.0, 98.0, 99.0, 100.0, 101.0, 102.0, 103.0, 104.0, 105.0, 106.0, 107.0, 108.0, 109.0, 110.0, 111.0, 112.0, 113.0, 114.0, 115.0, 116.0, 117.0, 118.0, 119.0, 120.0, 121.0, 122.0, 123.0, 124.0, 125.0, 126.0, 127.0, 128.0, 129.0, 130.0, 131.0, 132.0, 133.0, 134.0, 135.0, 136.0, 137.0, 138.0, 139.0, 140.0, 141.0, 142.0, 143.0, 144.0, 145.0, 146.0, 147.0, 148.0, 149.0, 150.0, 151.0, 152.0, 153.0, 154.0, 155.0, 156.0, 157.0, 158.0, 159.0, 160.0, 161.0, 162.0, 163.0, 164.0, 165.0, 166.0, 167.0, 168.0, 169.0, 170.0, 171.0, 172.0, 173.0, 174.0, 175.0, 176.0, 177.0, 178.0, 179.0, 180.0, 181.0, 182.0, 183.0, 184.0, 185.0, 186.0, 187.0, 188.0, 189.0, 190.0, 191.0, 192.0, 193.0, 194.0, 195.0, 196.0, 197.0, 198.0, 199.0, 200.0, 201.0, 202.0, 203.0, 204.0, 205.0, 206.0, 207.0, 208.0, 209.0, 210.0, 211.0, 212.0, 213.0, 214.0, 215.0, 216.0, 217.0, 218.0, 219.0, 220.0, 221.0, 222.0, 223.0, 224.0, 225.0, 226.0, 227.0, 228.0, 229.0, 230.0, 231.0, 232.0, 233.0, 234.0, 235.0, 236.0, 237.0, 238.0, 239.0, 240.0, 241.0, 242.0, 243.0, 244.0, 245.0, 246.0, 247.0, 248.0, 249.0, 250.0, 251.0, 252.0, 253.0, 254.0, 255.0, 256.0, 257.0, 258.0, 259.0, 260.0, 261.0, 262.0, 263.0, 264.0, 265.0, 266.0, 267.0, 268.0, 269.0, 270.0, 271.0, 272.0, 273.0, 274.0, 275.0, 276.0, 277.0, 278.0, 279.0, 280.0, 281.0, 282.0, 283.0, 284.0, 285.0, 286.0, 287.0, 288.0, 289.0, 290.0, 291.0, 292.0, 293.0, 294.0, 295.0, 296.0, 297.0, 298.0, 299.0, 300.0, 301.0, 302.0, 303.0, 304.0, 305.0, 306.0, 307.0, 308.0, 309.0, 310.0, 311.0, 312.0, 313.0, 314.0, 315.0, 316.0, 317.0, 318.0, 319.0, 320.0, 321.0, 322.0, 323.0, 324.0, 325.0, 326.0, 327.0, 328.0, 329.0, 330.0, 331.0, 332.0, 333.0, 334.0, 335.0, 336.0, 337.0, 338.0, 339.0, 340.0, 341.0, 342.0, 343.0, 344.0, 345.0, 346.0, 347.0, 348.0, 349.0, 350.0, 351.0, 352.0, 353.0, 354.0, 355.0, 356.0, 357.0, 358.0, 359.0, 360.0, 361.0, 362.0, 363.0, 364.0, 365.0, 366.0, 367.0, 368.0, 369.0, 370.0, 371.0, 372.0, 373.0, 374.0, 375.0, 376.0, 377.0, 378.0, 379.0, 380.0, 381.0, 382.0, 383.0, 384.0, 385.0, 386.0, 387.0, 388.0, 389.0, 390.0, 391.0, 392.0, 393.0, 394.0, 395.0, 396.0, 397.0, 398.0, 399.0, 400.0, 401.0, 402.0, 403.0, 404.0, 405.0, 406.0, 407.0, 408.0, 409.0, 410.0, 411.0, 412.0, 413.0, 414.0, 415.0, 416.0, 417.0, 418.0, 419.0, 420.0, 421.0, 422.0, 423.0, 424.0, 425.0, 426.0, 427.0, 428.0, 429.0, 430.0, 431.0, 432.0, 433.0, 434.0, 435.0, 436.0, 437.0, 438.0, 439.0, 440.0, 441.0, 442.0, 443.0, 444.0, 445.0, 446.0, 447.0, 448.0, 449.0, 450.0, 451.0, 452.0, 453.0, 454.0, 455.0, 456.0, 457.0, 458.0, 459.0, 460.0, 461.0, 462.0, 463.0, 464.0, 465.0, 466.0, 467.0, 468.0, 469.0, 470.0, 471.0, 472.0, 473.0, 474.0, 475.0, 476.0, 477.0, 478.0, 479.0, 480.0, 481.0, 482.0, 483.0, 484.0, 485.0, 486.0, 487.0, 488.0, 489.0, 490.0, 491.0, 492.0, 493.0, 494.0, 495.0, 496.0, 497.0, 498.0, 499.0, 500.0, 501.0, 502.0, 503.0, 504.0, 505.0, 506.0, 507.0, 508.0, 509.0, 510.0, 511.0, 512.0, 513.0, 514.0, 515.0, 516.0, 517.0, 518.0, 519.0, 520.0, 521.0, 522.0, 523.0, 524.0, 525.0, 526.0, 527.0, 528.0, 529.0, 530.0, 531.0, 532.0, 533.0, 534.0, 535.0, 536.0, 537.0, 538.0, 539.0, 540.0, 541.0, 542.0, 543.0, 544.0, 545.0, 546.0, 547.0, 548.0, 549.0, 550.0, 551.0, 552.0, 553.0, 554.0, 555.0, 556.0, 557.0, 558.0, 559.0, 560.0, 561.0, 562.0, 563.0, 564.0, 565.0, 566.0, 567.0, 568.0, 569.0, 570.0, 571.0, 572.0, 573.0, 574.0, 575.0, 576.0, 577.0, 578.0, 579.0, 580.0, 581.0, 582.0, 583.0, 584.0, 585.0, 586.0, 587.0, 588.0, 589.0, 590.0, 591.0, 592.0, 593.0, 594.0, 595.0, 596.0, 597.0, 598.0, 599.0, 600.0, 601.0, 602.0, 603.0, 604.0, 605.0, 606.0, 607.0, 608.0, 609.0, 610.0, 611.0, 612.0, 613.0, 614.0, 615.0, 616.0, 617.0, 618.0, 619.0, 620.0, 621.0, 622.0, 623.0, 624.0, 625.0, 626.0, 627.0, 628.0, 629.0, 630.0, 631.0, 632.0, 633.0, 634.0, 635.0, 636.0, 637.0, 638.0, 639.0, 640.0, 641.0, 642.0, 643.0, 644.0, 645.0, 646.0, 647.0, 648.0, 649.0, 650.0, 651.0, 652.0, 653.0, 654.0, 655.0, 656.0, 657.0, 658.0, 659.0, 660.0, 661.0, 662.0, 663.0, 664.0, 665.0, 666.0, 667.0, 668.0, 669.0, 670.0, 671.0, 672.0, 673.0, 674.0, 675.0, 676.0, 677.0, 678.0, 679.0, 680.0, 681.0, 682.0, 683.0, 684.0, 685.0, 686.0, 687.0, 688.0, 689.0, 690.0, 691.0, 692.0, 693.0, 694.0, 695.0, 696.0, 697.0, 698.0, 699.0, 700.0, 701.0, 702.0, 703.0, 704.0, 705.0, 706.0, 707.0, 708.0, 709.0, 710.0, 711.0, 712.0, 713.0, 714.0, 715.0, 716.0, 717.0, 718.0, 719.0, 720.0, 721.0, 722.0, 723.0, 724.0, 725.0, 726.0, 727.0, 728.0, 729.0, 730.0, 731.0, 732.0, 733.0, 734.0, 735.0, 736.0, 737.0, 738.0, 739.0, 740.0, 741.0, 742.0, 743.0, 744.0, 745.0, 746.0, 747.0, 748.0, 749.0, 750.0, 751.0, 752.0, 753.0, 754.0, 755.0, 756.0, 757.0, 758.0, 759.0, 760.0, 761.0, 762.0, 763.0, 764.0, 765.0, 766.0, 767.0, 768.0, 769.0, 770.0, 771.0, 772.0, 773.0, 774.0, 775.0, 776.0, 777.0, 778.0, 779.0, 780.0, 781.0, 782.0, 783.0, 784.0, 785.0, 786.0, 787.0, 788.0, 789.0, 790.0, 791.0, 792.0, 793.0, 794.0, 795.0, 796.0, 797.0, 798.0, 799.0, 800.0, 801.0, 802.0, 803.0, 804.0, 805.0, 806.0, 807.0, 808.0, 809.0, 810.0, 811.0, 812.0, 813.0, 814.0, 815.0, 816.0, 817.0, 818.0, 819.0, 820.0, 821.0, 822.0, 823.0, 824.0, 825.0, 826.0, 827.0, 828.0, 829.0, 830.0, 831.0, 832.0, 833.0, 834.0, 835.0, 836.0, 837.0, 838.0, 839.0, 840.0, 841.0, 842.0, 843.0, 844.0, 845.0, 846.0, 847.0, 848.0, 849.0, 850.0, 851.0, 852.0, 853.0, 854.0, 855.0, 856.0, 857.0, 858.0, 859.0, 860.0, 861.0, 862.0, 863.0, 864.0, 865.0, 866.0, 867.0, 868.0, 869.0, 870.0, 871.0, 872.0, 873.0, 874.0, 875.0, 876.0, 877.0, 878.0, 879.0, 880.0, 881.0, 882.0, 883.0, 884.0, 885.0, 886.0, 887.0, 888.0, 889.0, 890.0, 891.0, 892.0, 893.0, 894.0, 895.0, 896.0, 897.0, 898.0, 899.0, 900.0, 901.0, 902.0, 903.0, 904.0, 905.0, 906.0, 907.0, 908.0, 909.0, 910.0, 911.0, 912.0, 913.0, 914.0, 915.0, 916.0, 917.0, 918.0, 919.0, 920.0, 921.0, 922.0, 923.0, 924.0, 925.0, 926.0, 927.0, 928.0, 929.0, 930.0, 931.0, 932.0, 933.0, 934.0, 935.0, 936.0, 937.0, 938.0, 939.0, 940.0, 941.0, 942.0, 943.0, 944.0, 945.0, 946.0, 947.0, 948.0, 949.0, 950.0, 951.0, 952.0, 953.0, 954.0, 955.0, 956.0, 957.0, 958.0, 959.0, 960.0, 961.0, 962.0, 963.0, 964.0, 965.0, 966.0, 967.0, 968.0, 969.0, 970.0, 971.0, 972.0, 973.0, 974.0, 975.0, 976.0, 977.0, 978.0, 979.0, 980.0, 981.0, 982.0, 983.0, 984.0, 985.0, 986.0, 987.0, 988.0, 989.0, 990.0, 991.0, 992.0, 993.0, 994.0, 995.0, 996.0, 997.0, 998.0, 999.0, 1000.0, 1001.0, 1002.0, 1003.0, 1004.0, 1005.0, 1006.0, 1007.0, 1008.0, 1009.0, 1010.0, 1011.0, 1012.0, 1013.0, 1014.0, 1015.0, 1016.0, 1017.0, 1018.0, 1019.0, 1020.0, 1021.0, 1022.0, 1023.0, 1024.0, 1025.0, 1026.0, 1027.0, 1028.0, 1029.0, 1030.0, 1031.0, 1032.0, 1033.0, 1034.0, 1035.0, 1036.0, 1037.0, 1038.0, 1039.0, 1040.0, 1041.0, 1042.0, 1043.0, 1044.0, 1045.0, 1046.0, 1047.0, 1048.0, 1049.0, 1050.0, 1051.0, 1052.0, 1053.0, 1054.0, 1055.0, 1056.0, 1057.0, 1058.0, 1059.0, 1060.0, 1061.0, 1062.0, 1063.0, 1064.0, 1065.0, 1066.0, 1067.0, 1068.0, 1069.0, 1070.0, 1071.0, 1072.0, 1073.0, 1074.0, 1075.0, 1076.0, 1077.0, 1078.0, 1079.0, 1080.0, 1081.0, 1082.0, 1083.0, 1084.0, 1085.0, 1086.0, 1087.0, 1088.0, 1089.0, 1090.0, 1091.0, 1092.0, 1093.0, 1094.0, 1095.0, 1096.0, 1097.0, 1098.0, 1099.0, 1100.0, 1101.0, 1102.0, 1103.0, 1104.0, 1105.0, 1106.0, 1107.0, 1108.0, 1109.0, 1110.0, 1111.0, 1112.0, 1113.0, 1114.0, 1115.0, 1116.0, 1117.0, 1118.0, 1119.0, 1120.0, 1121.0, 1122.0, 1123.0, 1124.0, 1125.0, 1126.0, 1127.0, 1128.0, 1129.0, 1130.0, 1131.0, 1132.0, 1133.0, 1134.0, 1135.0, 1136.0, 1137.0, 1138.0, 1139.0, 1140.0, 1141.0, 1142.0, 1143.0, 1144.0, 1145.0, 1146.0, 1147.0, 1148.0, 1149.0, 1150.0, 1151.0, 1152.0, 1153.0, 1154.0, 1155.0, 1156.0, 1157.0, 1158.0, 1159.0, 1160.0, 1161.0, 1162.0, 1163.0, 1164.0, 1165.0, 1166.0, 1167.0, 1168.0, 1169.0, 1170.0, 1171.0, 1172.0, 1173.0, 1174.0, 1175.0, 1176.0, 1177.0, 1178.0, 1179.0, 1180.0, 1181.0, 1182.0, 1183.0, 1184.0, 1185.0, 1186.0, 1187.0, 1188.0, 1189.0, 1190.0, 1191.0, 1192.0, 1193.0, 1194.0, 1195.0, 1196.0, 1197.0, 1198.0, 1199.0, 1200.0, 1201.0, 1202.0, 1203.0, 1204.0, 1205.0, 1206.0, 1207.0, 1208.0, 1209.0, 1210.0, 1211.0, 1212.0, 1213.0, 1214.0, 1215.0, 1216.0, 1217.0, 1218.0, 1219.0, 1220.0, 1221.0, 1222.0, 1223.0, 1224.0, 1225.0, 1226.0, 1227.0, 1228.0, 1229.0, 1230.0, 1231.0, 1232.0, 1233.0, 1234.0, 1235.0, 1236.0, 1237.0, 1238.0, 1239.0, 1240.0, 1241.0, 1242.0, 1243.0, 1244.0, 1245.0, 1246.0, 1247.0, 1248.0, 1249.0, 1250.0, 1251.0, 1252.0, 1253.0, 1254.0, 1255.0, 1256.0, 1257.0, 1258.0, 1259.0, 1260.0, 1261.0, 1262.0, 1263.0, 1264.0, 1265.0, 1266.0, 1267.0, 1268.0, 1269.0, 1270.0, 1271.0, 1272.0, 1273.0, 1274.0, 1275.0, 1276.0, 1277.0, 1278.0, 1279.0, 1280.0, 1281.0, 1282.0, 1283.0, 1284.0, 1285.0, 1286.0, 1287.0, 1288.0, 1289.0, 1290.0, 1291.0, 1292.0, 1293.0, 1294.0, 1295.0, 1296.0, 1297.0, 1298.0, 1299.0, 1300.0, 1301.0, 1302.0, 1303.0, 1304.0, 1305.0, 1306.0, 1307.0, 1308.0, 1309.0, 1310.0, 1311.0, 1312.0, 1313.0, 1314.0, 1315.0, 1316.0, 1317.0, 1318.0, 1319.0, 1320.0, 1321.0, 1322.0, 1323.0, 1324.0, 1325.0, 1326.0, 1327.0, 1328.0, 1329.0, 1330.0, 1331.0, 1332.0, 1333.0, 1334.0, 1335.0, 1336.0, 1337.0, 1338.0, 1339.0, 1340.0, 1341.0, 1342.0, 1343.0, 1344.0, 1345.0, 1346.0, 1347.0, 1348.0, 1349.0, 1350.0, 1351.0, 1352.0, 1353.0, 1354.0, 1355.0, 1356.0, 1357.0, 1358.0, 1359.0, 1360.0, 1361.0, 1362.0, 1363.0, 1364.0, 1365.0, 1366.0, 1367.0, 1368.0, 1369.0, 1370.0, 1371.0, 1372.0, 1373.0, 1374.0, 1375.0, 1376.0, 1377.0, 1378.0, 1379.0, 1380.0, 1381.0, 1382.0, 1383.0, 1384.0, 1385.0, 1386.0, 1387.0, 1388.0, 1389.0, 1390.0, 1391.0, 1392.0, 1393.0, 1394.0, 1395.0, 1396.0, 1397.0, 1398.0, 1399.0, 1400.0, 1401.0, 1402.0, 1403.0, 1404.0, 1405.0, 1406.0, 1407.0, 1408.0, 1409.0, 1410.0, 1411.0, 1412.0, 1413.0, 1414.0, 1415.0, 1416.0, 1417.0, 1418.0, 1419.0, 1420.0, 1421.0, 1422.0, 1423.0, 1424.0, 1425.0, 1426.0, 1427.0, 1428.0, 1429.0, 1430.0, 1431.0, 1432.0, 1433.0, 1434.0, 1435.0, 1436.0, 1437.0, 1438.0, 1439.0, 1440.0, 1441.0, 1442.0, 1443.0, 1444.0, 1445.0, 1446.0, 1447.0, 1448.0, 1449.0, 1450.0, 1451.0, 1452.0, 1453.0, 1454.0, 1455.0, 1456.0, 1457.0, 1458.0, 1459.0, 1460.0, 1461.0, 1462.0, 1463.0, 1464.0, 1465.0, 1466.0, 1467.0, 1468.0, 1469.0, 1470.0, 1471.0, 1472.0, 1473.0, 1474.0, 1475.0, 1476.0, 1477.0, 1478.0, 1479.0, 1480.0, 1481.0, 1482.0, 1483.0, 1484.0, 1485.0, 1486.0, 1487.0, 1488.0, 1489.0, 1490.0, 1491.0, 1492.0, 1493.0, 1494.0, 1495.0, 1496.0, 1497.0, 1498.0, 1499.0, 1500.0, 1501.0, 1502.0, 1503.0, 1504.0, 1505.0, 1506.0, 1507.0, 1508.0, 1509.0, 1510

her testing date and mechanism- storage- transport- etc. =his was done b6 reducing the total yield b6 the recommended level of 10% and arriving at the net yield. =hen to determine the gross benefit b6 multiplying net yield b6 the yield price (market price adjusted for 6 costs related to storage-transport- etc.). =hen all costs and benefit of each treatment were calculated separately to arrive at the net benefit of each treatment. =his was helped researchers identify treatments with highest benefit for application of

lime. Set benefits and costs that were between treatments were used to calculate margin rate of return to investment capital as to move from less expensive to more expensive treatment. Economic analysis was carried considering only the purchasing cost of inputs as farmers normally use 5ml6 labor to process- transport and apply lime and fertilizers to crop fields. Therefore- sensitivity analysis was made to see the sensitivity of the recommended rate when subjected to input and output price changes.

Table 4. Partial Budget of in-depth trial.

Partial budget	Treatment							
	RL+ NPSB	0.75 RL+NPSB	0.5 RL+NPSB	0.25 RL+NPSB	Only RL	Only NPS	Only NPSB	Control
3 : (Dt h ⁻¹)	% .'	%0.&	7.2	'6	''.7	'&.!'	0.	27.1
+ : (Dt h ⁻¹)	!!17	%.!1	2. !	'&.''	'0.''	'%.12	'6.'6	2 . '&
34 . (. irrh ⁻¹)	2021.2	'&'&6.6	'6%'2.!	'!2'!	260!'!	'0!0%.2	'126&.6	20&7%.
Lre* (. irr/100 Ag)	1260.6&	1260.6&	1260.6&	1260.6&	0	1260.6&	1260.6&	0
\$ (# (. irr/100 Ag)	0	0	0	0	0	1271	0	0
\$ (# . (. irr/100 Ag)	0	0	0	0	0	0	12!1.7!	
8+ (100 birr /d*6)	00	'00	200	100	00	0	0	0
=< / (. irr/h*)	1660.6&	1%60.6&	1 60.6&	1'60.6&	00	1271	12!1.7!	0
\$et benefit	0'67.%	'7!'%.&1	'%072.11	'2 6'.11	2%6!'!	2&%'.2	2&&!7.12	20&7%.
9 , ,	2.							

Note: - , 8Qrecommended lime- 3 : Q3r*in field- + : Q+adjusted : field- 34 . Q3rowth 4ield . enesit- 8+Q8ime +pplication- =< / Q=ot*! ?*ri*ble / ost *nd 9 , , Q9 *rgin*! , *tes of return.

=he results of partial budget analysis date are shown in (table) according to the highest net benefit (0'67.% 0= .) was obtained from \$ (# . with full recommended lime treatment followed \$ (# . with 7% of full recommended lime treatment '7!'%.&10 . =he highest margin rate of return (2 '@) was obtained from \$ (# . with full recommended lime treatments. In this experiment- it was found that blended fertilizer application alone did not increase the maize yield on farmers' field due to acidity problem.

4. Conclusion and Recommendations

In this experiment- it was found that blended application of fertilizer alone did not increase the maize yield but greater due to acidity problem. =his agreement with report of E1 F that showed fertilizer application alone did not significantly increase the yield of crops in these unless it is applied along with lime or inorganic fertilizers due to severe nutrient depletions prevailing in these areas. In such a case- application of lime raises the pH and makes the nutrients available to crops. =he current experiment confirmed that lime is essential but must be complemented with blended plant nutrients in order to get adequate maize yield in the study areas. Hence it is economically feasible to improve maize yield and yield components on acidic soils of the study area by combined use of lime and \$ (# . fertilizer. =herefore- soil test based lime and \$ (# . application can be used for the sustainable production of maize on acidic soils in Ethiopia. According to 100% - 7% and 0% recommended lime rates had statistically significant effect on yield and 100% recommended lime with 100Ag/h* \$ (# . blended is best on the study area.

5. Prospects

Effects of blended fertilizer and lime rate on maize have the best option to tackle acidity problem and increase crop production. However various aspects remain to be investigated.

=hus- future research endeavor should focus on:

1. Combined blended fertilizer and lime application based on their properties is needed.
2. Research institution should focus on solving of acidity problem as main work.

Conflict of Interest

=he all authors declare that there is no conflict of interest regarding the publication of this article.

Acknowledgements

=he author thanks Jimm* / +# / + (0 (project for the financial support provided to conduct the experiment. Also " would like acknowledge . edele +gricultural , esearch / enter for their cooperation during field work and soil laboratory analysis.

References

- E1F 4ood and +griculture)rgani7ation /orporate #t#tistic#l ; *t#b#se (4+)#=#). 2017. #t#tistic#l d#t#b#ses and d#t#- sets of the 4ood and +griculture)rgani7ation of the United #tations.

- E2F 9 *c*ule6- H. *nd , *m*djit* =- 201%. /ere*I crops: rice- m*i7e- millet- sorghum *nd whe*t. +bdou ; iou5 "ntern*tion*I- ; *A*r #eneg*I.
- E'F 9 *c*ul*6- H. 201%. /ere*I crops: rice- m*i7e- millet- sorghum- *nd whe*t: b*cAground p*per. /on5erence on T4eeding +5ric*B ; *A*r- #eneg*I- 21U2') ctober 201%.
- E F #hi5er*w . oAe- 9 uluget* H*bte- +tin*5u + *nd +b*6 +6*lew. 201!. 9 *cro *nd 9 iconutrients 5or optimi7ing m*i7e production *t H*w*ss* Iuri* ; istrict- #outhern 0thiopi*. Journ*I o5 . iolog6 +gricuture *nd He*Ithc*re- !: 222 -'20!.
- E%F ; *gne /himdess*. 2016. .lended 4ertili7er 05sects on 9 *i7e : ield *nd : ield components o5 Gestern) romi*- 0thiopi*. +gricuture- 4orestr6 *nd 4isherries- (%) : 1%1-162.
- E6F 0thiopi*n #oil "n5orm*tion #6stem (0thio#") (2016). #oil *n*I6sis report. +gricuture*I =r*ns5orm*tion +genc6 (Lnpublished).
- E7F =es*6e . *lemi- 9 es5in Mebede- 3eber #el*ssie H*ilu- J*iros, urind*- J*mes 9 utegi- =olch* =u5*- =oler* +ber* *nd =es*6e #hi5er*w #id*. 201&. : ield , esponse *nd \$utrient Lse 055icienciasunder ; i55erent 4ertili7er +pplic*ions in 9 *i7e (*Zea mays* 8.) in /ontr*sting +gro0cos6stem. "ntern*tion*I Journ*I o5 (l*nt *nd #oil #cience. 2& (')- pp. 1-1&.
- E1F +=+ (+gricuture*I =r*ns5orm*tion +genc6)- 201 . #oil 4ertilit6 #t*tus *nd 4ertili7er , ecommend*tion +tl*s 5or =igr*6 , egion*I #t*te- 0thiopi*. 0thiopi*n +gricuture*I =r*ns5orm*tion+genc6 (+=+)- +. +.- 0thiopi*.
- E&F +ch*lu /himdi- Helu5 3ebreAid*n- MibebewMibret *nd +bi =*desse- 2012- #t*tus o5 selected ph6sicochemic*I properties o5 soils under di55erent l*nd use s6stems o5 Gestern) romi*- 0thiopi*. Journ*I o5 . iodi?ersit6 *nd On?ironment*I #ciences, 2 ('): %7-71.
- E10F +breh* Mid*nem*ri*m- Helu5 3ebreAid*n- =eA*Iign 9 *mo *nd Mindie =es*6e. 201'. Ghe*t crop response to liming m*terj*ls *nd \$ *nd (5ertili7ers in *cidic soils o5 =segede highl*nds- northern 0thiopi* +gricuture- Journ*I o5 4orestr6 *nd 4isherries 2 ('): 126-1' %.
- E11F 9 *rcelo /uritib* Ospindul*- <*lterle6#o*res , och*- 9 o*cil+I?es de #ou7*. 9 *rcel* / *mp*nh*ro- *nd 3uilherme de #ous* (*ul*. 201'. , *tes o5 ure* with or without ure*se inhibitor 5or topdressing whe*t. /hile*n journ*I o5 *gricuture*I rese*rch 7' (2).
- E12F 4*geri* \$. M- . *lig*r <. /- Jones /. + (2010). 3rowth *nd miner*I nutrition o5 5ield crops 'rd 0dition. / , / (ress.
- E1'F +lem*6ehu +bde*. 05sect o5 .lended 4ertili7er *nd 8ime +pplic*ion , *tes on 3r*in : ield *nd : ield /omponent o5 9 *i7e (*Zea mays* 8.) in) mo \$ *d* ; istrict- Jimm* Ione #outh-western- 0thiopi*. +meric*n Journ*I o5 . ioscience *nd . ioengineering. <ol. &- \$o. - 2021- pp. &1-10'. doi: 10.116 !/j.bio.20210&0 .11.
- E1 F G*ssie- H*ile- #hi5er*w . oAe. 200&. 9 itig*tion o5 soil *cidit6 *nd 5ertilit6 decline ch*llenges 5or sust*in*ble li?elihood impro?ement: rese*rch 5indings 5rom southern region o5 0thiopi* *nd its polic6 implic*ions.
- E1%F Hillette H*ilu- =eA*Iign 9 *mo- , iIAA*MesAinen- OriA M*rltun- Helu5 3ebreAid*n V =*6e . eAele. 201%. #oil 5ertilit6 st*tus *nd whe*t nutrient content in <ertisol cropping s6stems o5 centr*I highl*nds o5 0thiopi*.
- E16F ; *wid- 201!. <*lid*tion o5 .lended 4ertili7er 5or 9 *i7e (roduction Lnder 8imed /ondition o5 +cid #oil Journ*I o5 \$ *tur*I #ciences , ese*rch ! (2'): %2-%!.
- E17F =eA*Iign 9 *mo- MesAinen- , . M*rltun- 0- 3ebreAid*n- H.- V . eAele- =. 201%. #oil 5ertilit6 st*tus *nd whe*t nutrient content in <ertisols cropping s6stems o5 centr*I highl*nds o5 0thiopi*. +gricuture V 4ood #ecurit6- 1-10.
- E1!F . uni + 201 . 05sects o5 8iming +cidic #oils on "mpro?ing #oil (roperties *nd : ield o5 H*ricot . e*n. J On?iron +n*I =o>ica 11(1d) e9 . 9 9 B(2)-176 179. 178 B) 16 : 29. 17628 () 2686 i.) 27513 9 i 442