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# Fertilizer management strategy to reduce global warming potential and improve soil fertility in a Nitisol in Southwestern Ethiopia

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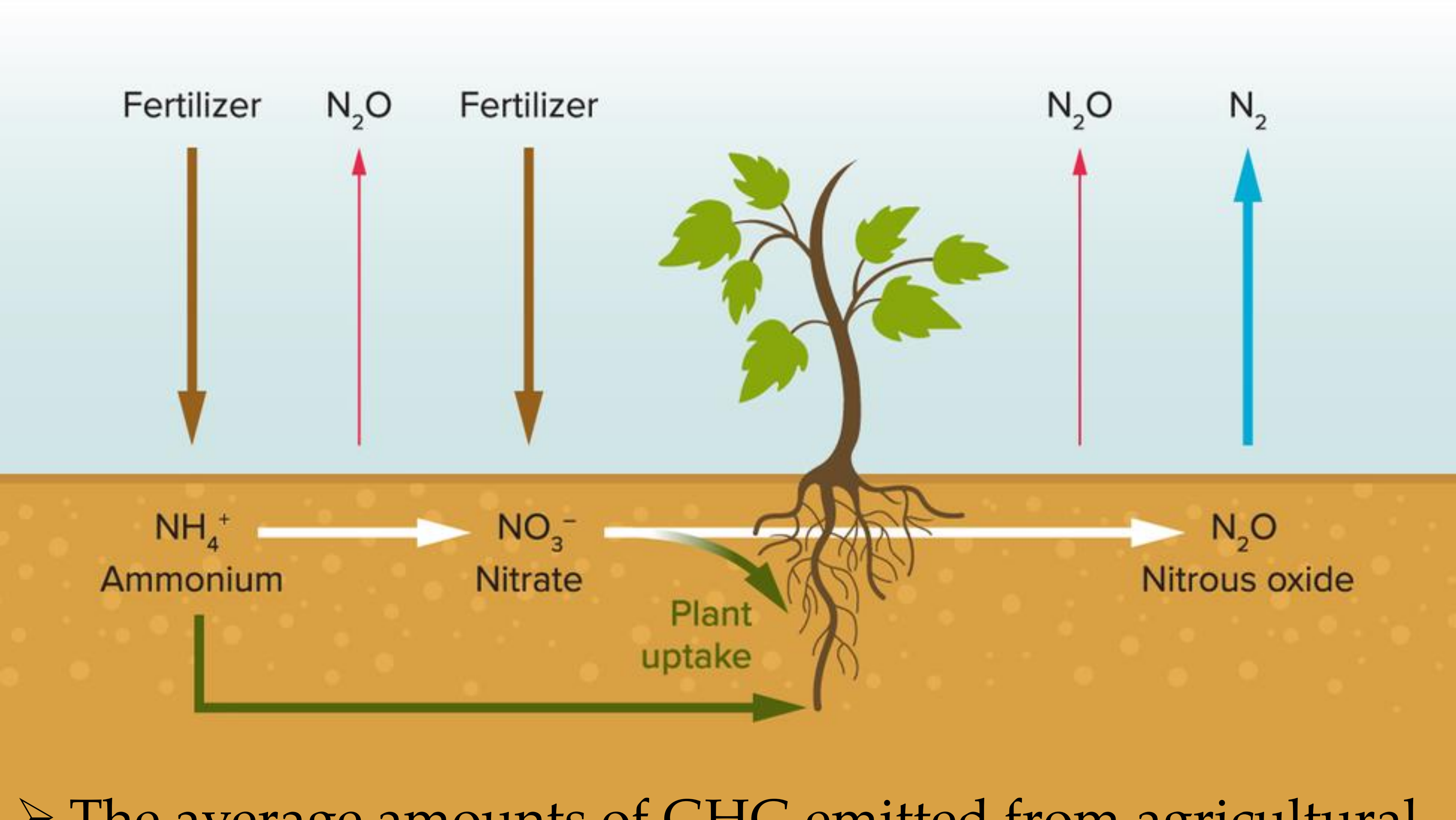
# Introduction




- The average amounts of GHG emitted from agricultural soils are estimated to be **14%** of the total global GHG emissions and thereby accelerate GWP.

- The current fertilizer management practice in Ethiopia is characterized by;
  - ✓Low amount with limited nutrient types
  - ✓Low productivity, and low GHG emissions

- Based on the global average value Ethiopia is contributing insignificant amount of GHGs **(0.03%)** emissions as a global warming potential, from all agricultural activities (Raji and Dörsch, 2020; Worku, M. A., 2020).

- However, Ethiopia aimed to increase the use of mineral fertilizer per hectare from **65 kg $ha^{-1}$** in 2010 to **247 kg $ha^{-1}$ in 2030** (Worku, M. A., 2020).
- In addition, $N_2O$ emissions from mineral fertilizer expected bout 58% in 2030 from total soil based emissions, and
- Will increase from **4.3 Mt $CO_2e$** in 2010 to **35 Mt $CO_2e$** in 2030 of GWP.
- As a result the increasing trend in N fertilizer application rate is expected to increase $N_2O$ emission in double increase GWP.

- Combined uses of organic and mineral amendments have been widely used as a means for soil fertility improvement (Ejigu et al., 2021; Mamuye et al., 2021).

- However, the effect of soil fertilizer management practices on GWP and soil quality is less understood in agricultural soils of Ethiopia.

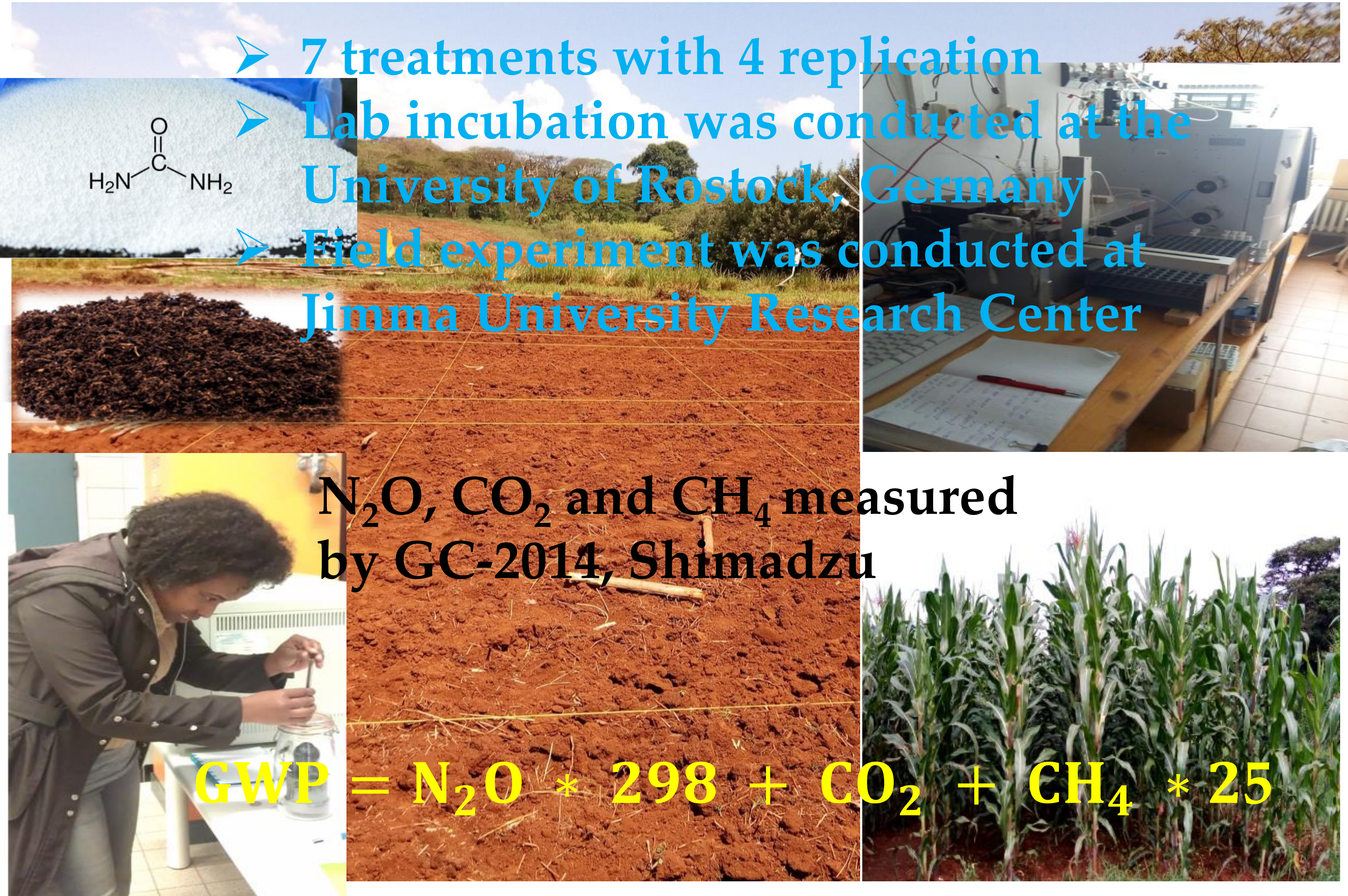
- The study evaluated the effects of combined application of biowaste compost and mineral fertilizers on GWP, and soil fertility in a Nitisol.

# Materials and Methods

- 7 treatments with 4 replication
- Lab incubation was conducted at the University of Rostock, Germany
- Field experiment was conducted at Jimma University Research Center

$N_2O$, $CO_2$ and $CH_4$ measured by GC-2014, Shimadzu

$$GWP = N_2O * 298 + CO_2 + CH_4 * 25$$



# Results and Discussions

- The treatment with 100min was significantly ($P$<0.05) increased by 27.1% , 30.4% and 34% of the average GWP values compared to 80min, 50min and 30min treatments respectively in wet soil.

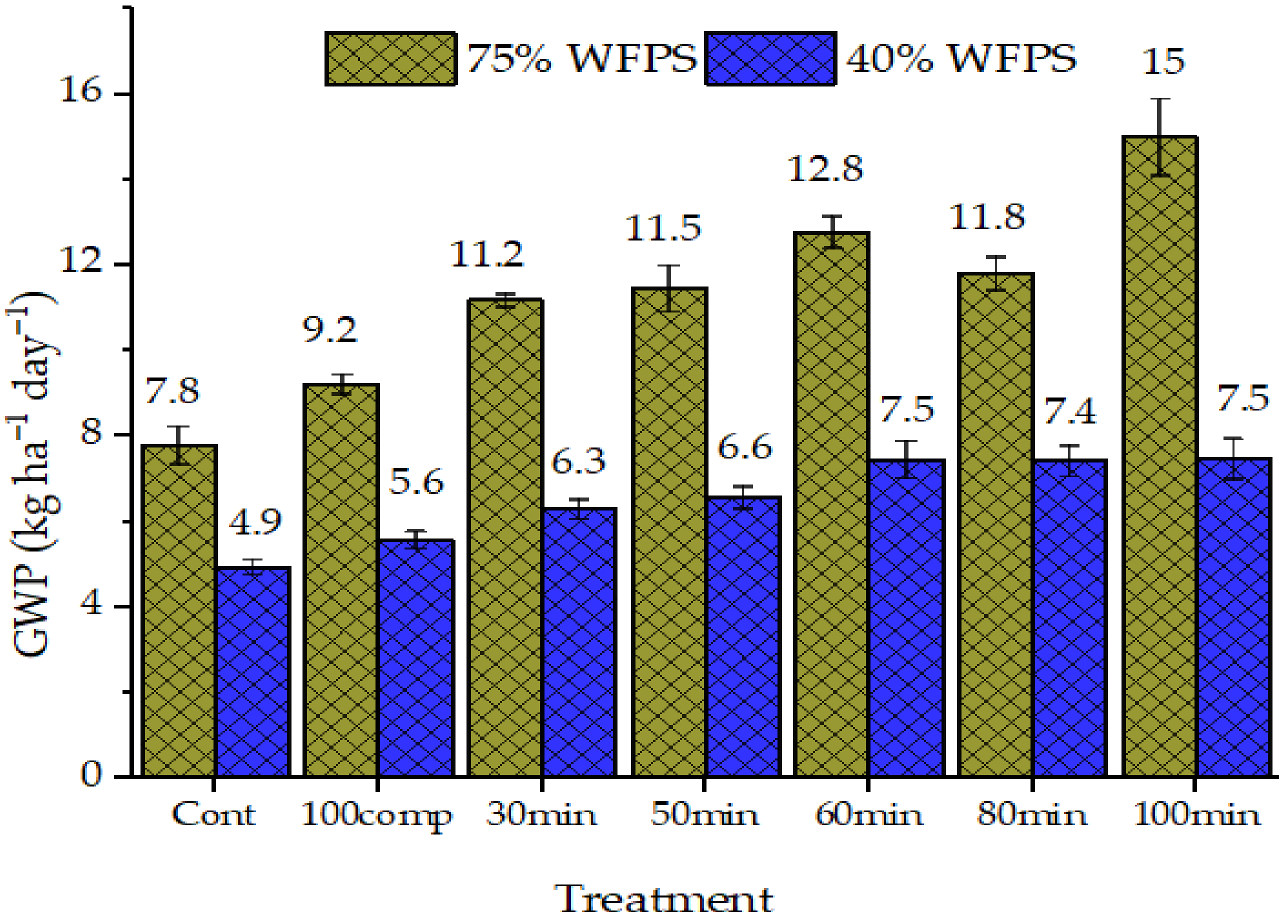



Figure S1. Global warming potential (GWP) in different fertilizer types and water filled pore-space (WFPS) (40% and 75%).

- This may be attributed to;
  - slow release of mineral nitrogen by microbial activity and
  - low contribution to GHGs emissions in combined fertilizer applied jars compared to 100min treatment
- Due to the low GHG contribution, combined fertilizer application could reduce GWP.

# Table S1. Soil minerals (mg kg$^{-1}$ soil) and chemical

| Soil parameters | Treatment | | | | | | |
|---|---|---|---|---|---|---|---|
| | Cont | 100min | 80min | 60min | 50min | 30min | 100comp |
| **Fe** | 46.5± 2.8$^{ab}$ | 52 ± 2$^{ab}$ | 65 ± 3.1$^{ab}$ | 58.9 ± 3.5$^{ab}$ | 48.2 ± 2.8$^{ab}$ | 13.5 ± 2.1$^{b}$ | 3.7 ± 0.6$^{a}$ |
| **Ca** | 266.1 ± 21$^{a}$ | 162.64 ± 30$^{b}$ | 350.3± 11.6$^{d}$ | 356.2 ± 21.2$^{d}$ | 281.69 ± 34.07$^{a}$ | 437.1 ± 38.9$^{c}$ | 121.7 ± 7.3$^{b}$ |
| **Mg** | 30.4 ± 2.3$^{abd}$ | 16.3 ± 2.9$^{a}$ | 47.7 ± 6.5$^{cd}$ | 42.9 ± 9.7$^{d}$ | 57.3 ± 10.5$^{c}$ | 40.2 ± 3.3$^{bd}$ | 20.5 ± 1.4$^{a}$ |
| **K** | 27.9 ± 3.6$^{a}$ | 61.7 ± 12.2$^{e}$ | 90.5 ± 6.3$^{bc}$ | 122.8 ± 11.2$^{d}$ | 108.6 ± 1.6$^{d}$ | 101.48 ± 7.89$^{c}$ | 75 ± 5.2$^{be}$ |
| **N** | 227.5± 17.1$^{a}$ | 332.5 ± 26.3$^{bd}$ | 315 ± 23.8$^{ad}$ | 371 ± 21.6$^{b}$ | 335.3 ± 12.8$^{bd}$ | 350 ± 18.3$^{bd}$ | 285 ± 17.3$^{a}$ |
| **P** | 0.3± 1$^{a}$ | 0.2 ± 0.05$^{a}$ | -0.14 ± 0.1$^{a}$ | 0.4±0.1$^{a}$ | 0.07 ± 0.01$^{a}$ | -0.02 ±0.01$^{a}$ | 0.6 ± 0.1$^{a}$ |
| **S** | 45 ± 12$^{a}$ | -2.2 ± 1.02$^{a}$ | 20 ± 8.02$^{a}$ | 10 ± 2.1$^{a}$ | 235 ± 55.1$^{b}$ | 30 ± 4.1$^{a}$ | 15±2.8$^{a}$ |
| **C** | 2375± 95.7$^{a}$ | 2575 ± 359.4$^{a}$ | 2975 ± 596.5$^{ac}$ | 3250 ± 70.2$^{bc}$ | 3600 ± 81.7$^{b}$ | 3475 ± 221.7$^{bc}$ | 3875 ± 170.8$^{b}$ |
| **Zn** | 8.4 ±1.2$^{ab}$ | 7.9±2.1$^{ab}$ | 18.2 ± 1.5$^{c}$ | 10.1±91$^{abc}$ | 7.5±1.3$^{ab}$ | 12 ± 0.4$^{bc}$ | 2.8±0.4$^{a}$ |
| **Mn** | 158 ± 16.8$^{a}$ | 182.5 ± 17.3$^{a}$ | 407.6 ± 64.3$^{b}$ | 238.3 ±2 0.3$^{c}$ | 181.4 ± 12.7$^{ac}$ | 38.5 ± 14.6$^{b}$ | 179 ± 2$^{a}$ |
| **pH** | 0.04 ± 0.01$^{a}$ | 0.14 ± 0.01$^{bc}$ | 0.16 ± 0.04$^{bc}$ | 0.17 ± 0.03$^{bc}$ | 0.15±0.06$^{bc}$ | 0.20±0 005$^{b}$ | 0.09 ± 0.01$^{ac}$ |
| **Ec** | 0.2 | 0.2 | 0.17 ± 0.02$^{a}$ | 0.20±0.008$^{a}$ | 0.17 ± 0.008$^{a}$ | 0.16±0.01$^{a}$ | 0.18 ± |

- Carbon 26.21–39.81%
- Calcium, 73.2–168.8%
- Magnesium 146.6–251.5%
- Potassium 47–99%

Were increased in combined fertilizer in comparison to 100min treatment

## Conclusion

- Combined application of compost and mineral fertilizer can be an option to;
  - ✓ reduce GWP and
  - ✓ improving soil quality and in Nitisols in Southwestern Ethiopia

# Recommendation

- ❖ We recommend that 30 kg N or 50 kg N in combination with compost of 4.9 or 3.5 t $ha^{-1}$ be applied in Nitisol to;
  - ✓ reduce GWP and
  - ✓ improve soil fertility in smallholder farming system
- ❖ Future investigations would be recommended to evaluate GHG emission at the farm conditions

# Acknowledgment

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Thank You