# Profit and productivity optimisation of bean and maize production for small farms in Paraguay

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## ABSTRACT

Current smallholder's production system is inefficient and unsustainable, with low yields and low economic performance to develop and maintain a satisfactory quality of life. This research aims to develop a productivity optimisation model for the smallholder by evaluating different fertilisation systems.

## INTRODUCTION

In Paraguay, 264,047 family farms (plots up to 50 ha) cultivate approximately 1,960,081 ha of farm land. Agriculture for this sector is mainly for subsistence, and 36,22 % of the rural families are living below the poverty line (~ 3.79 AUD/day). Low crop yields due to poor soil management (no fertilisation) along with the farmer's mentality (investment is for big farms) contributed to unsustainable production practices, leading to poverty.

The purpose of this research was to demonstrate to small farmers that traditional crops (beans and maize) if adequately managed can generate enough revenue to cover fertilisation investment cost and earn an extra profit.

## METHODS

Experimental plots (25m x 25m) were programmed in a two-year crop rotation system of maize and beans. Using randomized block design, field crop experiments were set up in a degraded soil (*Ultisol*) to test fertilization alternatives

| Maize - Treatments | Beans - Treatments |
|---|---|
| $T_1$: Control | $T_1$: Control |
| $T_2$: 750 Kg/ha $CaCO_3$ | $T_2$: 1.2 t/ha $CaCO_3$ |
| $T_3$: 20-30-25 kg/ha of N-$P_2O_5$-$K_2O$ | $T_3$: 10-20-20 kg/ha of N-$P_2O_5$-$K_2O$ |
| $T_4$: 40-60-50 kg/ha of N-$P_2O_5$-$K_2O$ | $T_4$: 20-40-40 kg/ha of N-$P_2O_5$-$K_2O$ |
| $T_5$: 60-90-75 kg/ha of N-$P_2O_5$-$K_2O$ | $T_5$: 40-80-80 kg/ha of N-$P_2O_5$-$K_2O$ |
| $T_6$: 750 Kg/ha $CaCO_3$ + 40-60-50 kg/ha of N-$P_2O_5$-$K_2O$ | $T_6$: 1.2 t/ha $CaCO_3$ + 20-40-40 kg/ha of N-$P_2O_5$-$K_2O$ |
| $T_7$: Cow Manure 40 t/ha | $T_7$: Cow Manure 40 t/ha |
| $T_8$: Cow Manure 40 t/ha + 20-30-25 kg/ha of N-$P_2O_5$-$K_2O$ | $T_8$: Cow Manure 40 t/ha + 0-60-40 kg/ha of N-$P_2O_5$-$K_2O$ |
| $T_9$: Cow Manure 40 t/ha + 40-60-50 kg/ha of N-$P_2O_5$-$K_2O$ | $T_9$: Cow Manure 40 t/ha + 10-70-50 kg/ha of N-$P_2O_5$-$K_2O$ |
| $T_{10}$: Cow Manure 40 t/ha + 60-90-75 kg/ha of N-$P_2O_5$-$K_2O$ | $T_{10}$: Cow Manure 40 t/ha + 10-90-80 kg/ha of N-$P_2O_5$-$K_2O$ |

Fixed cost (cultivation cost) were the same for all treatments within each crop. Variable cost were considered as the cost incurred for each fertilisation alternative. Return on investment (ROI) and yield were used to decide on the best fertilisation option.

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## RESULTS

A positive response to the different fertilising strategies was observed. All treatments surpassed the yield registered by the control and some the national average of Maize and Beans (see figure below)

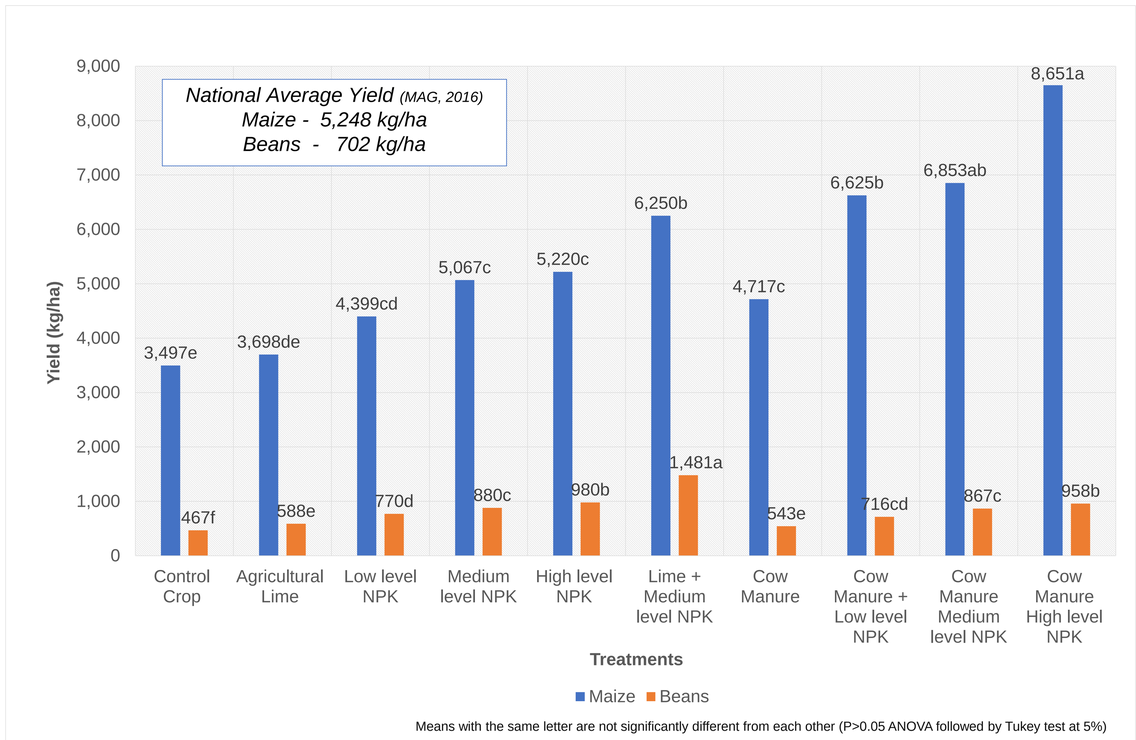


Figure 1. Effects of different fertilisation strategies (chemical and organic) on yields of Maize and Beans in Santa Rosa Misiones, Paraguay

Regarding return on investment (Best treatments):
Maize - ROI 232% (700 kg/ha of Ag. lime + Medium level of N-$P_2O_5$-$K_2O$ 40-60-50 kg/ha).

Bean - ROI 52% (1,2 t/ha of Ag. lime + Medium level of N-$P_2O_5$-$K_2O$ 20-40-40 kg/ha).

## CONCLUSION

Investing in fertiliser is profitable and proved to increase yields by up to 147 % for maize and 105 % for beans. This study also highlights the economic benefits of intensifying smallholder production systems in a move away from subsistence, increasing awareness about economic decision making in production system. Further research is needed to integrate the results of this experiment into whole-farm management in Paraguay.

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