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ECONOMIC RETURN, YIELD AND HARVEST INDEX OF INTEGRATED NITROGEN IN 85,000 PLANTS Ha^{-1} ON Zea mays AGRIBUSINESS IN PESAWAR, PAKISTAN

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ABSTRAK

Jagung merupakan salah satu pangan pokok bagi penduduk dunia. Penelitian bertujuan untuk mengetahui kelayakan usahatani jagung dengan teknologi pemupukan N terintegrasi dengan kerapatan tanam 85,000 tanaman per hektar. Penelitian dilaksanakan dalam rancangan acak kelompok yang diulang empat kali. Perlakuan pemupukan Nitrogen terintegrasi terdiri dari control, 0% pupuk kandang + 100% Urea, 100 % pupuk kandang + 0 % Urea, 50% pupuk kandang + 50% Urea, 75% pupuk kandang + 25% Urea and 25% pupuk kendang + 75% Urea). Parameter yang diukur adalah hasil panen, indek hasil panen, biaya total, pendapatan, keuntungan dan nisbah B/C. Hasil penelitian menunjukkan bahwa pemberian Nitrogen terintegrasi dengan dosis 50% pupuk kandang dengan dosis 50% urea mencapai hasil panen 4.394,44 $kgha^{-1}$, indek hasil panen 33.4%, Biaya Total 36.961 PKR, pendapatan total 227.941 PKR, keuntungan 190.980 PKR dan nisbah B/C adalah 6,2. Usahatani jagung sangat layak untuk dilanjutkan.

Kata kunci: nisbah B/C, Nitrogen terintegrasi, keuntungan

ABSTRACT

Zea mays are one of the staple food for the population in the world. The research aimed to determine the economic return of integrated nitrogen and spacing. The research was conducted in RCB design, having four replications. Integrated nitrogen were assigned to treatment that consisted of control (IN_1), 0% Farmyard Manure + 100 % Urea (IN_2), 100 % Farmyard Manure + 0 % Urea (IN_3), 50 % Farmyard Manure+ 50 % Urea (IN_4), 75 % Farmyard Manure + 25 % Urea (IN_5) and 25 % Farmyard Manure + 75 % Urea (IN_6). Data were recorded on plant harvest, harvest index, and benefit-cost ratio. The result showed the treatment of integrated nitrogen application of 50 % Farmyard Manure and 50% urea produced the highest B/C ratio (6.2). It is concluded that 50% F Farmyard Manure + 50% Urea and the spacing of 85000 plants ha^{-1} enhanced yield. Harvest index 33,4%, yield 4219.44 kg^{-1}. Total cost 36.961PKR, total income 227.941 PKR economic net return 190.980PKR. *Zea mays* agribusiness is feasible to continue.

Keywords: Benefit-cost ratio; Integrated-nitrogen; net return

INTRODUCTION

Zea mays L. is a widely grown crop and plays a vital role in food security (Shi et al., 2016). Among cereals, *Zea mays* rank after rice and wheat. A hundred gram of fresh *Zea mays* grains contain 74.4 g carbohydrates, 4.3 g fats, 361 calories, 1.8 g fiber, 9.4 g of protein, and 1.3 g vitamins (Ali et al., 2014; Hussain et al., 2019; Khan et al., 2017). *Zea mays* are globally known as cereals queen as it has highest genomic yield potential among other cereals. At the national level, the entire cultivated range was 1.23 million hectares with a production of 5702 thousand tonnes having an average yield of 4640 kg ha^{-1}, while in KP, the cultivated area was almost 474 thousand hectares with the production of 867 thousand tons and the average yield was 1827 kg ha^{-1} (*Pakistan Econ. Surv.*, 2020; Pakistan Government, 2020). Optimum, practical, and use of stable fertilizers show a central part in improvements and productivity on a sustainable basis. Nitrogen is an essential nutrient that limits the production of *Zea mays*.

It is typically initiated to be the most significant critical lacking constituent of the world of cultivated soils. Zea mays require nitrogen during the active growth and development periods, and it up-sets the dry matter production directly by inducing the photosynthetic efficiency and leaf area. Nitrogen optimal rate is compulsory to inhibit plant growth and yield (Srivastava et al., 2018). The use of nitrogen fertilizer significantly increased grain yield and biological. Organic and inorganic nitrogen sources display a positive interaction for enhancing crop yield (Shi et al., 2016). Experimentations revealed that combined nitrogen managements have a more significant impact over individual usage of inorganic or organic in expressions of enhanced fertility of the soil, secure nutrient supply, and crop yield. Inorganic and organic nutrients exhibited countless profits in N uptake increase by plant and soil available N. It also plays a vital role in enhancing *Zea mays* as fodder for animal production. Nitrogen modifies plants' competition further than several other nutrients as it is a central elementary component of numerous metabolites containing proteins, amino acids, phytochromes, and nucleic acids. The appropriate nitrogen levels with the augmented incorporation of farmyard manure achieve agreeable and palatable fodder yield (Duarte, 2007; Shamsabadi et al., 2017).

Planting density is the primary aspect for achieving greater yield categorical by Intra and inter positioning of rows. Planting population is a vital element of the yield of grain. In greater planting density, most plants endure unfertile ears that are vulnerable to the attack of pests and also to lodging. The ultimate number of plants per area depends on numerous features, i.e., accessibility of water, maturity of hybrid, fertility of the soil, and spacing between rows. An increase in density decreases the percent of shelling and lessening the weight of grain, grains number, and grains rows (Sangoi et al., 2002). Higher densities encourage solar radiation exploitation by canopies of *Zea mays*. Production of dry matter in the crop is openly linked to solar radiation exploitation, which is affected by shade. Many kinds of research about increasing the productivity of *Zea mays* have been carried out. Nevertheless, yet on economic aspect due to those experiments are still scarce. That is why it needs research about economic return and Benefit-cost ratio about this *Zea mays* crop agribusiness.

RESEARCH METHODS

The research was performed during 2018-19 at Agronomy Research Farm, UAP Pakistan, in RCB design replicated four times. The integrated nitrogen was consisted of six levels of integrated Nitrogen (IN_1 = control, IN_2 =0% Farmyard Manure + 100% Urea, IN_3 =100 % Farmyard Manure + 0 % Urea, IN_4 = 50% Farmyard Manure + 50% Urea, IN_5 = 75% Farmyard Manure + 25% Urea, IN_6 = 25% farmyard + 75% Urea) were applied to *Zea mays* crop. The seed rate, i.e., 30 kg ha^{-1}, was sown. Desired spacing 85000 ha^{-1} was retained with the process of thinning. The subplot's length and width were 3 m x 3.5 m, respectively accommodating a total of 6 rows. Spacing of 85000 plants ha^{-1} was maintained by adjusting R-R and P-P distance of 70 cm and 16.8 cm). Mineral N non-organic source was applied as urea, and the organic source was applied as farmyard manure. The characteristic of control was not given any Nitrogen. Variety Azam was sown for this research. The economic aspect was analyzed descriptively on total income, the total net return, and the Benefit-Cost Ratio.

At harvest maturity, plants in three central rows were counted and then harvested components to record plants at harvest. The measured parameter is total yield, grain yield, harvest index (recorded by the formula of grain yield/total yield x 100). Characteristics Unit Value of Farmyard Manure are Nitrogen (0.546 %), Phosphorus (0.225 %), Potassium (0.613 %), Dry matter (20.0 %), Moisture (80.0 %).

Table 1. Pre-sowing soil analysis status

Physio-chemical properties	Values
Texture	Silt Loam
Bulk density	1.153 g cm^{-3}
pH (1.5 soil water extract)	7.78
EC (1.5 soil water extract)	0.17 ds m^{-1}
Lime content	17.15 %
Organic matter content	0.77 %
Total nitrogen	0.37 %
Extractable phosphorous	4.72 mg kg^{-1}
Extractable potassium	83.28 mg kg^{-1}

The equation model for analysis are following:

$$X_{qi} = \mu + r_q + N_i + \varepsilon_{qij}$$

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Where X_{qi} is the randomized variable of integrated nitrogen, μ is the general average, r_q is replication, N_i is the integrated nitrogen, ε_{qij} is component of error.

On economic aspect gains data information for income of *Zea mays* used formula as followed:

$$Л = TR - TC$$

$$TR = P.Q$$

$$TC = TFC + TVC$$

Where all unit is in Pakistan Rupee (PKR), Л = *Zea mays* income, TR = Total Revenue, TC = Total cost, P = Price, Q = Quantity, TFC = Total Fixed Cost, TVC = Total Variable Cost.

The business feasibility of *Zea mays* used formulas as followed:

$$\frac{B}{C}\ ratio = \frac{TR}{TC}$$

If B/C ratio > 1 means the business is feasible, if B/C ratio = means break-even and B/C < 1 means the business is not feasible, no benefit economically.

RESULTS AND DISCUSSION

Total Yield

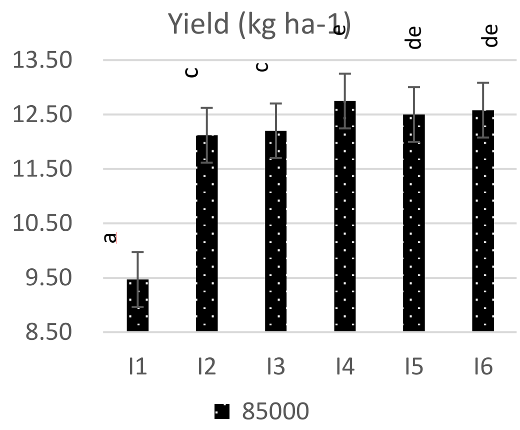
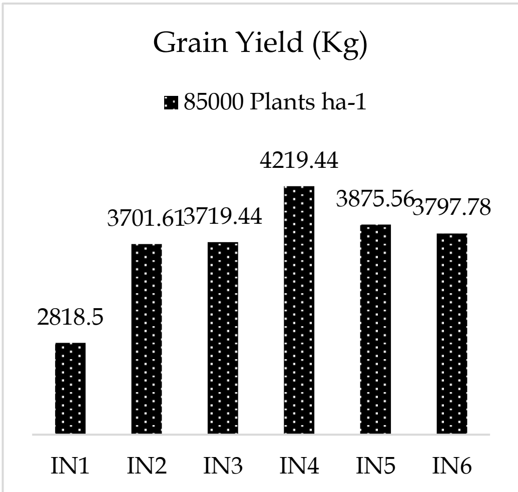


Figure 1. The total yield of Zea mays agribusiness within Integrated Nitrogen

Grain Yield

Zea mays crop reached total yield better than control (without any treatment of Farmyard Manure and urea) for each integrated nitrogen treatment. Whereas the highest yield was at 50% Farmyard Manure+ 50% Urea, spacing 85,000 plants ha^{-1} was 4219.44 kg ha^{-1}. It could have happened because the growth was still optimum (Shi et al., 2016). The result is proportional to nutrient, light intensity competition. However, spacing of 75 cm x 15 cm (88,880 ha^{-1}) is the highest yield of



4900 kg ha^{-1} under a coconut tree (Kartika, 2018), and the population 70 cm x 20 cm resulted from 7900 kg ha-1 with zero tillage using BIMA hybrid variety in Indonesia (Biba, 2015). The yield of *Zea mays* in Indonesia was higher than in Pakistan. Nevertheless, the price in Indonesia is lower than in Pakistan. Therefore, the net return and Benefit-cost ratio in Pakistan is higher than in Indonesia.

Figure 2. Grain Yield of *Zea mays* as affected by integrated nitrogen

Developed technologies can increase agriculture's sustainability and reduce its impact on the environment (Cameron et al., 2013; Cameron et al., 2014). The higher result gained in Indonesia that spacing *Zea mays* plant 20 x 50 with animal manure 15 ton ha^{-1} increased growth and yield of *Zea mays* individually (Asbur et al., 2019) and (Sari, 2019).

Harvest index (%)

Harvest index of *Zea mays* crop as affected by planting density, and integrated nitrogen is presented in Figure 3. Planting density and integrated nitrogen had significantly (P≤0.05) affected the harvest index. Interaction of planting density and integrated nitrogen was non-significant. An increasing trend was obtained by planting density up to the particular integrated N of 50% Farmyard Manure + 50% Urea. However, it decreased, moving towards the integrated nitrogen of 75% Farmyard Manure + 25% Urea and 25% Farmyard Manure + 75% Urea. The maximum harvest index was produced by planting density of 85000 plants ha^{-1} with 50% Farmyard Manure + 50% Urea.

It might be due to the timely availability of N and the increase in water-holding soil capability. Nitrogen impacted harvest index significantly in combination with Farmyard Manure. *Zea mays* yield of grains turns down after planting populations beyond optimal planting populations mainly due to a decline in harvest index and increased lodging in the stem. The findings revealed that suitable and stable nutrient supply by manuring mixing and inorganic N practicing might have enlarged comparatively incredible assimilates percent during developments.

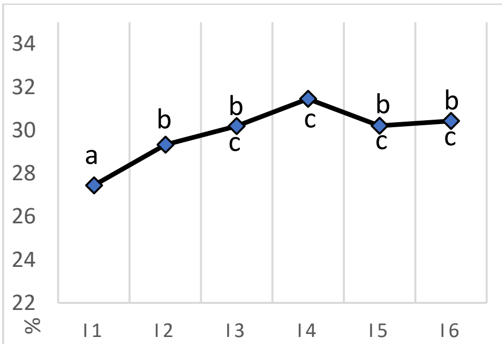


Figure 3. Harvest index of *Zea mays* as affected by integrated nitrogen and planting density.

These results are in line with Shah et al. (2007) and (Cisse et al., 2019) that *Zea mays* harvest index was influenced by inorganic and organic combination. Furthermore, application of 30 m^3ha^{-1} pig farm-yard-manure and 20 kg ha^{-1} biofertilizers has reduced at least 50% of the NPK without declining grain yields in the

North China Plain—proposed that planting density inversely proportional to the ear diameter on sweet corn. Increasing planting density leads to thinning of ear diameter. It is because of the competition in the dense populations. Planting density could be due to the effects of interplant competition for light, water, nutrient, and other potential yield-limiting environmental factors (Ashrafi & Seiedi, 2011). According to (Cameron et al., 2013; Cameron et al., 2014), spacing above critical density harms yield per plant due to the effects of interplant competition for light, water, nutrient, and other potential yield-limiting environmental factors. The superiority emanates from the fast release of nutrients from the inorganic fertilizers with resultant timely provision of nutrients for *Zea mays* crops in the early stages of growth, unlike the slow release of nutrients by the organic fertilizer counterpart. A similar description for stem girth responds to organic and inorganic nutrients supply (Kartika, 2018); (Shi et al., 2016). Nutrient contents of organic sources are the soil amendment for crops and provided the appreciable amount of nitrogen. (Mamiev et al., 2019) reported that the combined use of straw, nitrogen fertilizers, and green manure contributed to obtaining the largest potato crop, while the increase in comparison with control was 34.0%. Soils receiving farmyard manure, poultry manure, and filter cake alone or mineral N improved the soil organic carbon (C), total N, P, and K status. Organic N sources release nutrients slowly and contribute to the residual pool of organic N and P in the soil and reduce N leaching. The higher organic carbon is a result of integrated nitrogen applications (Biba, 2015).

Minimum total soil N is based on the fact that N from mineral source is soluble and can quickly be lost from soils through leaching and gas emissions, resulting in reduced fertilizer efficiency compared with organic N sources (Duarte, 2007; Shamsabadi et al., 2017). Integrated nitrogen might be attributed to the mineralization of organic matter and N sources' residual effect, which enhanced the N levels of the soil. Our findings are supported by (Asbur et al., 2019) and (Sari 2019). They reported that application of nitrogen from mineral N and farmyard manure increased soil total N. (Cisse et al., 2019) concluded that 30 m^3 ha^{-1} pig farm-yard-manure and 20 kg ha^{-1} biofertilizers application has reduced at least 50% of the chemical fertilizer NPK with grain yields remained in the North China Plain. Combined application of organic manures and NPK increase the soil total N. Nutrient contents of organic sources served as a soil amendment for crops and provided appreciable quantities of N. (Mamiev et al., 2019) reported. Soils receiving farmyard manure, poultry manure, and filter cake alone or mineral N improved the soil organic carbon (C), total N, P, and K status. Organic N sources release nutrients slowly and contribute to the residual pool of organic N and P in the soil and reduce N leaching. Organic N sources comparatively mineralized slowly than mineral N, which resulted from improvement in soil organic matter. The significance of organic sources in improving the physical, chemical, and biological properties of soil is well documented (Cisse et al., 2019)

Organic N sources such as poultry manure filter cake and farmyard manures constitute a valuable source of nutrients and organic matter and improve soil physical properties and soil organic matter (Muñoz et al., 2004). Organic N sources increase soil nutrients and organic matter with long-lasting residual effects on crop yield and soil properties (Cisse et al., 2019)). Reported the greater agronomic use efficiency by integrated use of nitrogen. Similar results were proposed by (Achieng et al., 2010); (Asbur et al., 2019) and (Sari, 2019).

Economic Return

The Zea mays' economic return that presented in Table 1 showed that 50% Farmyard Manure + 50% Urea reached total yield 3927.41 kg, total cost 36961 PKR, Total income 36961, Total income 212765 PKR, Net return 175804 PKR and B/C ratio 5.8. 75% Farmyard Manure + 25% Urea reached the same B/C ratio.

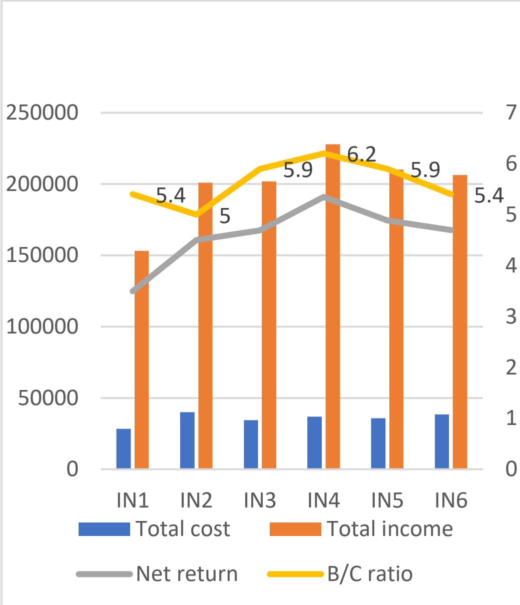


Figure 4. The economic return of Zea mays in Integrated Nitrogen

Control treatment's total cost is the lowest (28,355 PKR) among integrated nitrogen treatments in all plant density treatments. The highest total cost when treatment used 100% urea (40,022 PKR) in all plant density treatments. The total cost for 100% Farmyard Manure decreases to 34,355 PKR. The treatment used 50% urea + 50% Farmyard Manure, the total cost spent by 36,961 PKR. The total cost decreased when Farmyard Manure used more than urea, such as 75% Farmyard Manure + 25% urea. Then reverse 25% Farmyard Manure + 75% urea, the total cost increased again. However, the price of farmyard manure was lower than urea.

The control treatment at all density showed the lowest net return among all integrated nitrogen treatments. Simultaneously, the higher nitrogen by the higher farmyard manure showed a higher net return. The highest net return owing to maize crop production was 190,980 PKR by the balanced dosage of 50% farmyard manure+50%urea in 85,000 plants/ha. The highest realizable value (6.2) indicated when maize crops were planted in 85,000 plants/ha in which the balance of farmyard manure and urea dosage at 50% farmyard manure + 50% Urea proportion.

CONCLUSION

The result showed the treatment of integrated nitrogen application of 50 % Farmyard Manure and 50% urea produced the highest B/C ratio (6.2). It is concluded that 50% F Farmyard Manure + 50% Urea and the spacing of 85000 plants ha^{-1} enhanced yield. Harvest index 33,4%, yield 4219.44 kg^{-1}. Total cost 36.961PKR, total income 227.941 PKR economic net return 190.980PKR. *Zea mays* agribusiness is feasible to continue.

REFERENCES

Achieng, J., Ouma, G., Odhiambo, G., & Muyekho, F. (2010). Effect of farmyard manure and inorganic fertilizers on maize production on Alfisols and Ultisols in Kakamega, western Kenya. *Agriculture and Biology Journal of North America*, *1*(4), 430–439. https://doi.org/10.5251/abjna.2010.1.4.430.439

Adeniyan, O. N., Aluko, O. A., Olanipekun, S. O., Olasoji, J. O., & Aduramigba-Modupe, V. O. (2014). Growth and Yield Performance of Cassava/Maize Intercrop Under Different Plant Population Density of Maize. *Journal of Agricultural Science*, *6*(8). https://doi.org/10.5539/jas.v6n8p35

Ali, Q., Ali, A., Awan, M., Tariq, M., Ali, S., Samiullah, T., Azam, S., Din, S., Ahmad, M., & Sharif, N. (2014). Combining ability analysis for various physiological, grain yield, and quality traits of Zea mays L. *Life Sci J*, *11*(8s), 540–551.

Asbur, Y., Rahmawati, & Adlin, M. (2019). Respon pertumbuhan dan produksi tanaman jagung (Zea mays L .) terhadap sistem tanam dan pemberian pupuk kandang sapi. *Agriland*, *7*(1), 9–16. https://jurnal.uisu.ac.id/index.php/agriland/article/view/1243

Ashrafi, V., & Seiedi, M. N. (2011). Influence of Different Plant Densities and Plant Growth Promoting Rhizobacteria (Pgpr) on Yield and Yield Attributes of Corn (Zea Maize L.). *Recent Research in Science and Technology*, *3*(1), 63–66. www.recent-science.com

Biba, M. A. (2015). Pengaruh Jarak Tanam dan Varietas Jagung Hibrida terhadap Pendapatan Petani. *Prosiding Seminar Nasional Serealia*, 745–750.

Cameron, K. C., Di, H. J., & Moir, J. L. (2013). Nitrogen losses from the soil_plant system_ a review -. *Annal of Applied Biology*, *162*(2), 145–173. https://doi.org/https://doi.org/10.1111/aab.12014C

Cameron, R. W. F., Taylor, J. E., & Emmett, M. R. (2014). What's "cool" in the world of green façades? How to plant choice influences the cooling properties of green walls. *Building and Environment*. https://doi.org/10.1016/j.buildenv.2013.12.005

Cisse, A., Arshad, A., Wang, X., Yattara, F., & Hu, Y. (2019). Contrasting impacts of long-term application of biofertilizers and organic manure on grain yield of winter wheat in north China plain. *Agronomy*, *9*(6). https://doi.org/10.3390/agronomy9060312

Dawadi, D. R., & Sah, S. K. (2012). *Growth and Yield of Hybrid Maize (Zea mays L .) in Relation to Planting Density and*

Nitrogen Levels during Winter Season in Nepal. *23*(3), 218–227.

Duarte, S. R. (2007). Different Periods. *Horticultura Brasileira*, 154–158.

Hussain, H. A., Men, S., Hussain, S., Chen, Y., Ali, S., Zhang, S., Zhang, K., Li, Y., Xu, Q., Liao, C., & Wang, L. (2019). Interactive effects of drought and heat stresses on morpho-physiological attributes, yield, nutrient uptake and oxidative status in maize hybrids. *Scientific Reports*, *9*(1), 1–12. https://doi.org/10.1038/s41598-019-40362-7

Kartika, T. (2018). Pengaruh Jarak Tanam terhadap Pertumbuhan dan Produksi Jagung (Zea Mays L) Non Hibrida di Lahan Balai Agro Teknologi Terpadu (ATP). *Sainmatika: Jurnal Ilmiah Matematika Dan Ilmu Pengetahuan Alam*, *15*(2), 129. https://doi.org/10.31851/sainmatika.v15i2.2378

Khan, A., Zahir Afridi, M., Airf, M., Ali, S., & Muhammad, I. (2017). A Sustainable Approach toward Maize Production: Effectiveness of Farm Yard Manure and Urea N. *Annals of Biological Sciences*, *05*(01), 7–13. https://doi.org/10.21767/2348-1927.1000103

Mamiev, D., Abaev, A., Tedeeva, A., Khokhoeva, N., & Tedeva, V. (2019). Use of green manure in organic farming. *Xii International Scientific COnference on Agricultural Machinery Industry*. https://doi.org/10.1088/1755-1315/403/1/012137

Muñoz, G. R., Kelling, K. A., Powell, J. M., & Speth, P. E. (2004). Comparison of Estimates of First-Year Dairy Manure Nitrogen Availability or Recovery Using Nitrogen-15 and Other Techniques. *Journal of Environment Quality*, *33*(2), 719. https://doi.org/10.2134/jeq2004.0719

Pakistan Economic Survey. (2020). Finance Division Government of Pakistan.

Pakistan Government. (2020). Pakistan Economic Survey: Agriculture. In *Pakistan Economic Survey* (pp. 1–23).

Sangoi, L., Gracietti, M. A., Rampazzo, C., & Bianchetti, P. (2002). Response of Brazilian maize hybrids from different eras to changes in plant density. *Field Crops Research*, *79*(1), 39–51. https://doi.org/10.1016/S0378-4290(02)00124-7

Sari, L. A. (2019). *Pertumbuhan Hasil Jagung dan Kacang Tunggak dalam sistem Tumpangsari*. *2011*, 102–116.

Shamsabadi, H., Ahmad, D., Yahya, A., & Aimrun, W. (2017). Yield components of sweet corn (Zea mays) and some soil physical properties towards different tillage methods and plant population. *Agricultural Engineering International: CIGR Journal*, *19*(3), 56–63.

Shi, D. yang, Li, Y. hong, Zhang, J. wang, Liu, P., Zhao, B., & Dong, S. ting. (2016). Increased plant density and reduced N rate lead to more grain yield and higher resource utilization in summer maize. *Journal of Integrative Agriculture*, *15*(11), 2515–2528. https://doi.org/10.1016/S2095-3119(16)61355-2

Srivastava, R. K., Panda, R. K., Chakraborty, A., & Halder, D. (2018). Enhancing grain yield, biomass and nitrogen use efficiency of maize by varying sowing dates and nitrogen rate under rainfed and irrigated conditions. *Field Crops Research*, *221*(March), 339–349. https://doi.org/10.1016/j.fcr.2017.06.019