

TECHNICAL BULLETIN

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Upscaling the Rice-Bean Cropping System for Increased Productivity

Beans play an important role in crop rotation, maintaining soil organic matter, fertility and productivity through nitrogen fixation, but the long growth duration of most bean cultivars does not allow them to fit into the period between T. Aman and Boro, the two major rice growing seasons in the country. Short-duration vegetable legumes, such as, country bean, mung bean, cow pea, pea and French bean may be the suitable alternatives. Mature green seeds of French bean and country bean are popular in greater Chattogram and Sylhet areas, while tender young seeds of French bean have a high export market value. *Lignosus* bean, being non-conventional and wild in nature in Bangladesh, has very little or no pest or disease infestation/infection and its physiologically mature green seeds can be consumed as a vegetable which is excellent in taste and flavor with a long shelf life. A rice-bean-rice cropping pattern with a short-duration T. Aman variety (e.g., Binadhan 7) and a late Boro variety (e.g., Binadhan 14) would provide a suitable time slot in between the two rice crops to grow a short-duration (70-90 days) bean crop, e.g., *Lignosus* bean, French bean, *felon*, pea, soybean, mung bean) as a vegetable areas many places of Bangladesh. This KGF sponsored project studied the possibility of incorporating short duration vegetable legumes into the existing rice based cropping patterns with the specific objectives of improving cropping system and soil productivity.



Fig. 1. Growing rice and bean in a T. Aman-bean-Boro sequence

Methodology

An experiment was initiated in 2018 at the field laboratory of the Crop Botany Department with a short-duration T. Aman rice variety (Binadhan-7) followed by beans (*Lignosus* bean, French bean, dwarf cowpea, pea, soybean and mung bean) and Boro rice (Binadhan-14). It was a two-factor experiment where factor A was a bean species (no bean, *felon*, *Lignosus* bean, pea, French bean, soybean and mung bean) and factor B was fertilizer management e.g., conventional fertilizer (CF), CF + micronutrient fertilizers (CFM) and CF + biofertilizer



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(CFB). Pre- and post-harvest soil samples were analyzed for organic C, Ca, Mg, P, S, Cu, Fe, Mn and Zn. In the first year of the project, experiments related to cultivation of T. Aman rice and beans in cropping patterns were conducted. Afterwards, validation trials in experimental fields and also in farmers' fields using the three best performing bean species were conducted. During July 2019-June 2020, beans and Boro rice were cultivated sequentially in experimental fields as well as in farmers' fields.

Results and Outputs

Unlike in the first year when T. Aman rice showed no significant variation in grain and straw yields, in the second year, significant variation in rice grain yield in Boro (4.52 to 6.32 t/ha) was observed. The highest Boro grain yield was observed in plots where the previous crop was French bean with CFB (conventional fertilizer plus biofertilizer) consortium treatment (34.2% increase over control, i.e., no bean plots). After Boro, the short-duration T. Aman rice variety, Binadhan-7, yielded between 3.92 and 5.69 t/ha with different treatment combinations. The highest rice grain yield increase was observed in previously felon plots with CF (conventional fertilizer) (26% increase over no bean plots).

In case of beans, species and fertilizer treatment both significantly influenced total pod and biomass yields. The total fresh biomass yield of bean ranged between 1 and 2 t/ha. Soybean, French bean and pea were found to be best compatible with the two rice-and-one bean cropping pattern, whose pods could be safely harvested at physiological maturity before Boro rice transplanting, but the short time in between two rice crops was found to be insufficient for mung, *Lignosus* beans and *felon* to mature and produce pods. *Felon*, although found unsuitable in terms of economic yield, gave the highest biomass yield among all the beans because of its heavy foliage. CF was found to be the best fertilizer management option that increased plant biomass yield of *felon*, soybean or mung bean, but for French bean CFB was found to be the best option. However, in terms of pod yield, CFM (conventional fertilizer plus micronutrients) was the best fertilizer management practice for most beans. However, despite a high biomass yield, the pod yield obtained from felon or mung bean was negligible, so these beans were excluded from the validation trials in farmers' fields. Incorporation of bean biomass into soil Boro and T. Aman grain yields by 19 and 13%, respectively.

Post-harvest soils analysis after each cropping season indicated an increase (ranging from 27.7% to 83.0% after Boro, and 1.8% to 58.2% after T. Aman) in soil organic carbon (SOC) in almost all bean plots compared with no bean plots. After Boro harvest, the highest SOC increase was observed in French bean plots with the CFM treatment.

In farmers' field trials, after T. Aman the three promising beans (French bean, pea and soybean) that produced better pod and biomass in experimental plots were grown applying two fertilizer management schemes, one with CF and the other with CFB. There was a slightly superior performance in both French bean and pea plots under CFB treatment compared with the CF. Surprisingly, no pod set was observed in soybean in the farmers' fields, which needs further investigation. After completion of the third year of the project, it was concluded that French bean and pea can be introduced in between a short-duration T. Aman rice crop such as, Binadhan-7 and Boro (late Boro like Binadhan-14) rice. Introduction of these bean species not only increased the system productivity but also improved soil fertility.

These results indicated that introduction of these bean species not only increased the agronomic system productivity of the system but also improved French bean and pea can be easily accommodated between *T. Aman* and *Boro* to enhance farmers' incomes with vegetable beans in addition to rice from two seasons; farmers' gross annual income was increased by 2.5 and 2.0-folds with French bean and pea, respectively (Fig. 2).

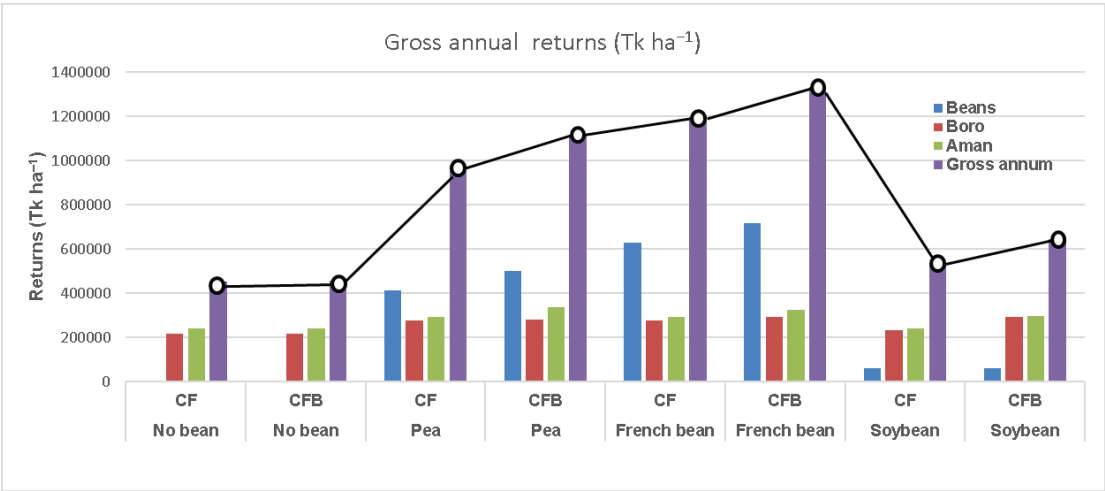


Fig. 2. Annual returns from the various beans; the trend line upon purple bars of seven different group-histograms represents gross return from an annual crop sequence including three different bean species (bean-Boro-Aman) under recommended fertilizer (CF), micronutrients (CFM), and biofertilizer (CFB) management

Expected Impact

These results indicated that beans can be grown in a range of soil and climatic conditions and they can play an important role in soil fertility and productivity through nitrogen fixation and organic matter addition. This project demonstrated that short-duration legumes such as, French bean, soybean and pea can be introduced in between T. Aman (short duration T. Aman variety such as, Binadhan-7) and Boro (late Boro like Binadhan-14) rice seasons of Bangladesh. The results were encouraging--introduction of these bean species can not only increase the system productivity of a rice-based cropping system and improved soil fertility but also can enhance rice farmers' incomes.

Recommendations

Many areas of the country has suitable agro-climatic conditions farmers can easily practice the rice-bean-rice cropping system. The findings of this project need to be validated in these areas before recommending the rice-bean cropping system for large scale adoption by farmers.

This technical bulletin has been prepared on the basis of technical information available from a completed BKGET-KGF Funded CGP Project the details of which are given below:

Project Code and Title: Upscaling Rice-bean Cropping System for Increased Yield, Nutrients and Soil Productivity

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