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Assessment of elephant foot yam (*Amorphophallus paeoniifolius* L.) – an efficient intercrop under guava (*Psidium guajava* L.) orchard for purvanchal district of Uttar Pradesh

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Abstract
Intercropping is the growing of two or more crops simultaneously in proximity. The most common goal of intercropping is to produce a greater yield on a given piece of land by making use of resources or ecological processes that would otherwise not be utilized by a single crop. The growth characters of Elephant footyam (suran) as intercrop were not affected by shade effect of guava trees or various other tree species. The Krishi Vigyan Kendra, Varanasi conducted Frontline demonstration on 08 farmers for each year since 2012-13, 2013-14 and 2014-15 in different locations of Varanasi district to evaluate the Elephant footyam as intercrop in guava orchard. The problem of poor orchard management and poor cultural practices in orchard management are solved when intercropping is done. The use of high yielding variety, balanced use of fertilizer on the basis soil testing report and integrated pest and disease management etc are the main technologies to be tested in this demonstration. The data of study revealed to the cost of cultivation, production, gross return and net return were collected as per schedule and analyzed. The result of present study revealed that average highest yield in demonstration was recorded 495.66 q/ha was obtained in demonstrated plot over control (370 q/ha) with an additional yield of 125.66 q/ha and the increasing the average tomato productivity by 34.0 per cent. The extension gap and technology gap ranged between 107 to 125 and 146 to 195 q/ha, respectively, with the technology index of 25.94 per cent during the demonstration years. Besides this, the demonstrated plots gave higher gross return, net return with higher benefit cost ratio when compared to farmer's practice. In present study efforts were also made to study the impact of FLD on horizontal spread which was increased 641.17%, if appropriate package and practices are followed.

Keywords: Elephant foot yam (suran), frontline demonstration, intercropping, yield, economy, extension gap, technological gap, purvanchal

1. Introduction
Suran is commonly known as Jimikand in India. The corms are irritant due to the presence of calcium oxalate. It can also used for pickles. The stems can be used as cattle feed. They are rich in nutrients and minerals. They are carminative, aperient and expectorant. The fresh ones are an acrid stimulant and expectorant and increase appetite and taste. They are applied to treat acute rheumatism. They are also used in dysentery, piles and haemorrhoids as recommended by Ayurveda.

India climate supports to grow an array of horticultural crops. A rich biodiversity in fruits, vegetables, and medicinal crops exist in our country which helped in development and transfer to technologies to receptive farmers, with the result of that our country now ranks second in the world in the combined production of fruits and vegetables. Poor orchard management is the most limiting factor of low productivity in major guava growing regions. Intercropping can not only improve the health of orchard but also generate additional income and employment to the farmers, without any adverse effect on guava production. Among all intercrops vegetable crops, especially tuber crops, are well suited under old guava plantation due to their shade loving nature. Suran can be grown suitably even in the dense shade of guava orchard. Keeping in view the suitability of efficient intercropping systems in the inter space of bearing guava orchard under variable agro-climatic conditions, the investigation were taken up to find out suitability of Elephant Foot Yam as intercrop in guava orchard of Purvanchal district of Uttar Pradesh.

Guava (*Psidium guajava* L.) is very famous and widely grown in India due its taste and medicinal value. It is fourth grown fruits after Mango, Banana and citrus in India. In India guava occupies an area of 2.03 lac hectares with annual production of 22.7 lacs MT (National

Horticulture Board 2014-15). Allahabad area in U.P is reputed for the production of high quality of guava in India and the world, which is much low compare to its potential. About 35% of total areas of guava plantation fall in Uttar Pradesh and Bihar. Poor orchard management and poor cultural practices are the main limiting factor of its low productivity in these regions. Prevalence of wilt disease is another cause of low productivity. Proper orchard management and cultural practices by growing Elephant footyam (suran) as inter crop in guava orchard has sown significant effect on the health of guava plantation.

Intercropping is the growing of two or more crops simultaneously in proximity. The most common goal of intercropping is to produce a greater yield on a given piece of land by making use of resources or ecological processes that would otherwise not be utilized by a single crop. Intercropping provides insurance against risk and gives stable returns even under unfavorable weather condition over while a mono-cropping practice does not. Its advantages are risk minimization, increased income and food security, reduction of soil erosion and pest and disease control. There is more cooperation in nature than competition. Cooperation is exemplified by mutually beneficial relationships that occur between species within communities. Kanwar *et al.* (1993) [17], Gosh, S. N. (2001) [18], Panda *et al*. (2003) [19], Rath and Swain (2006) [20] and Bhatnagar *et al*. (2007) [21] also work on different intercrops.

This paper discusses the practice of intercropping in horticultural crop production to promote sustainability

Materials and methods:

The Frontline demonstration was conducted by Krishi Vigyan Kendra, Varanasi, Narendra Dev University of Agriculture and Technology, Kumarganj, Faizabad for three consecutive years from 2012-13, 2013-14 and 2014-15 in the 08 farmer's field every year in different blocks of Varanasi district, Uttar Pradesh under normal conditions. Total 24 demonstrations were concluded in three years to assess the Elephant footyam (suran) variety Gajendra as inter crop in guava orchard. The local farmers generally used local seeds of suran as intercrops in orchard of this area are treated as control (farmers practice) for comparison and the difference between the demonstration and existing farmers practice are recorded in table 2.

The site of the experiment is situated at 25º.19' N latitude and 82º. 5f9' E longitude with an elevation of 84 meters above mean sea level. The varieties Gajendra sown in farmers field to evaluate the effect of shade on its yields. The sowing was done in the month of Fist week of March with the spacing 90 X 90 cm (plant to plant and between row to row). The seed corms of high yielding variety Gajendra were treated with mancozeb 0.3% (3 grams/Liter of water) for 25 to 30 minutes. These treated corms were dried under shade for 4 hours before planting in the field and mulching is done after sowing. The pits were filled with half top soil, well decomposed farm yard manure (FYM) @ 2 to 3 kg/pit and wood ash. The cultural practices adopted for cultivation of intercrops, had been tried to synchronize with the guava trees in order to avoid, any harmful impact on flowering and fruiting of guava trees. Recommended dose of fertilizer were applied on every trial. 250 qt/ha decomposed compost were applied before last ploughing with 80 kg/ha nitrogen, 60 kg/ha Phosphorus and 100 kg/ ha Potash and applying the 40:60:50 kg NPK/ha at 45 days after planting along with weeding and inter cultural operations. Rest amount is to be used as top dressing with 40:50N and K one month later along with shallow intercultural operations.

The observations on various parameters of growth and yield of Elephant footyam were recorded at proper stage of growth and maturity. Irrigation was done after immediate sowing and the crop is covered by mulching of grass or paddy straw. Then 15-20 days in rainy season and once in a week in rest of months.

In general, soils of the area under study were sandy to sandy loam with medium to low fertility status and the average annual rainfall of this area is 998 mm and temperature varies from 15 to 45 ^{0}C with average temperature 26.16 ^{0}C. The data of yield, pest management, production cost and returns were collected by KVK, scientists with frequent field visits during 2012-13 to 2014-15 from front line demonstration plots and farmers practice plot (control plot) and finally extension gap, technology gap, and technology index were calculated as given as formula suggested by Samui *et al.* (2000) [4] and Dayanand *et al.* (2012) [5] as given below.

Per cent increase in yield =Demonstration yield-farmers practice yield X 100 /Farmers practice yield

Technology gap = Potential yield -Demonstration yield

Extension gap =Demonstration yield-Yield under existing practice

Technology index =Potential yield-Demonstration yield X 100 /Potential yield

The data of adoption and horizontal spread of technologies were collected from the farmers with the interaction them. Data were subjected to suitable statistical methods. The following formulae were used to assess the impact on different parameters of tomato crop.

Impact of yield =Yield of demonstration plot- yield of control plot/Yield of control plot X 100

Impact on adoption (% change) =No. of adopters after demonstration- No. of adopters before demonstration /No. of adopters before demonstration X 100

Impact on horizontal Spread (% change) =after area (ha) - Before area (ha)

Results and discussion

Yield:

The perusal of data (Table 2) indicate that due to front line demonstration on Gajendra variety of Elephant footyam yield ranged from 485.0 q/ ha 504.0 q/ ha in demonstration plots and from 348.0 q/ ha to 383.0 q/ ha in farmer's practice plot in three years of demonstration and average yield of 495.66 q/ ha was obtained under demonstration plots as compared to 370.0 q /ha in farmers practice plots in same years. This results clearly indicated that the higher average yield in demonstration plots over the years compare to farmers practice due to knowledge and adoption of full package of practices i.e. use of bio fertilizer enriched FYM, recommended dose of fertilizers, us of high yielding variety, Sowing method and distance, mulching, and timely application of plant protection chemicals. The average yield of Gajendra variety of Elephant footyam is increased by 34.0 per cent. The yield of Gajendra variety of Elephant footyam could be increased over the yield obtained under farmers

practices (lack of knowledge on use of bio fertilizers, no use of the balanced dose of fertilizer, no IPM practices) of elephant footyam cultivation. The above findings are in similarity with the findings of Singh *et al.,* (2011) [6] and Similarly yield enhancement in different crops in frontline demonstrations were documented by Hiremath *et al.,* (2007) [7], Mishra *et al.* (2009) [8], Kumar *et al.,* (2010) [9],, Surywanshi and Prakash (1993) [13] and Dhaka *et al.* (2010) [11], Singh *et al*., (2014) [16] and Khan *et al.,* (2015) [15].

The increment in yield of Gajendra variety of Elephant footyam ranged between 30.74 to 34.72 per cent. The percent increase in yield over farmers practice was highest (34.72) during 2012-13. However variations in the yield of Elephant footyam in different years might be due to the variations in soil moisture availability, rainfall, and change in the location of demonstrations every year.

Extension gap: Extension gap of 125, 107 and 121 q/ha was observed during 2012-13, 2013-14 and 2014-15 respectively in Gajendra variety and local variety. On an average extension gap under three year FLD programme was 125.66 q/ha. This emphasized the need to educate the farmers through various techniques for the adoption of improved agricultural production technologies to reverse this trend of wide extension gap. More and more use of latest production technologies with high yielding variety will subsequently change this alarming trend of galloping extension gap.

Technology gap: The technology gap, the differences between potential yield and yield of demonstration plots was 165, 195 and 146 q /ha during 2012-13, 2013-14 and 2014-15 respectively. On an average technology gap under three year FLD programme was 154.33 q/ha. This may be due to the soil fertility, managerial skills of individual farmer's and climatic condition of the area. Hence, location specific recommendations are necessary to bridge these gaps. These findings are similar to Singh *et al.* (2011) [6] and Sharma and Sharma (2004)

Technology Index: The technology index shows the feasibility of the demonstrated technology at the farmer's field. The technology index varied from 22.46 to 30.0 (Table 2). On an average technology index of 25.94 per cent was observed during the three years of FLD programme, which shows the effectiveness of technical interventions. This accelerates the adoption of demonstrated technical interventions to increase the yield performance of Gajendra variety of Elephant footyam.

Economic returns: In order to found the economic feasibility of the demonstration technologies over and above the control, some economic indicators like cost of cultivation, net return and B:C ratio was worked out. The economic viability of improved demonstrated technology over farmers practice was calculated depending on prevailing price of inputs and outputs cost and represented in the term of B: C ratio (Table 3). It was found that the cost of production of Elephant footyam under demonstration varied from Rs. 86500 to 100000/ ha with an average of Rs. 93033.33 as against 82600 to 96500 with an average Rs. 89333.33 under control. The additional cost increased in demonstration was mainly due to more cost involved in balanced fertilizer, procurement of improved HYV seed and IPM practices. Girja Devi and Wahib (2007) singh *et al.* (1996) and Bhuva *et al.* (1998) also work on economics based intercropping systems.

The cultivation of Gajendra variety of Elephant footyam under improved technologies gave higher net return of Rs. 3,98,500/ha Rs. 3,62,400 /ha and Rs. 3,85,000 / ha in the year 2012-13, 2013-14 and 2014-15 respectively with an average net return of Rs. 3,81966/ha which was lower Rs. 273100/ha in farmer's practices. The benefit cost ratio of Elephant footyam ranged from 3.85 to 4.16 in demonstration plots and from 2.82 to 3.35 in farmer's practice plots during three years of demonstration with an average of 3.97 in demonstration and 3.04 under farmer's practices. This may be due to higher yield obtained and lower cost of cultivation under improved technologies compared to local check (farmers practice). This finding is similar with the findings of Singh *et a*l, (2011) [6]. Similar findings are also reported by Chapke (2012) [14] in case of jute.

The B: C ratio was recorded to be higher under demonstration against control during all the years of study. Scientific method of Elephant footyam cultivation can reduce the technology gap to a considerable extent, thus leading to increased productivity of Elephant footyam in varanasi district which in term will improve the economic condition of the growers. Moreover, extension agencies in the district need to provide proper technical support to the farmers through different educational and extension methods to reduce the extension gap for better Elephant footyam production in the Purvanchal Uttar Pradesh. These findings are similar to Singh *et al* (2014) [16] a.nd Khan *et al*. (2015) [15]

The result of improved technology intervention brought out that adoption of recommended high yielding variety Gajendra of Elephant footyam by farmers before demonstration was negligible, which increased by 128.57% after demonstration. Seed treatment, seed sowing method/distance and pits preparation technique was increased by 183.33% due to intervention through FLD. The overall adoption level of HYV Gajendra production technology was increased by about 304.25 percent due to FLD conducted by KVK, Varanasi (Table 4).

In present study efforts were made to study the impact of FLD on horizontal spread of Elephant footyam. Data in Table 5 showed that FLD organized on Elephant footyam crop helped to increase area under recommended. There was significant increase area under horizontally from 25.50 to 189.0 ha under Elephant footyam with impact percentage change of 641.17.

Conclusion: The FLD produced a significant positive result and provided an opportunity to demonstrate the productivity potential and profitability of the latest technology (intervention) under real farming situation. Therefore the study concludes that FLDs conducted by KVK, Varanasi made significant impact on horizontal spread of this technology. Therefore, target oriented training programme on intercropping of tuber vegetable production technology along with multiple demonstration is required to enhance the level of knowledge and skills of growers which help in adoption of technology. The availability of seed of HYV Gajendra at the time of sowing is very difficult and costly for farmers, so they have no choice to choose local variety in spite of Gajendra. The local horticulture departments of district will come forward to help the farmers by making easily availability of Elephant footyam seed. This could circumvent some of the constraints in the existing transfer of technology system in the Varanasi district of Uttar Pradesh. The productivity gain under FLD over existing practices of intercrop of HYV Gajendra (Elephant footyam) cultivation has created greater awareness and motivated other farmers to adopt the

demonstrated technologies for Elephant footyam production in the district which helps to enhance the tuber vegetable production consumption nutritional security and overall livelihood security of the districts of Purvanchal Uttar Pradesh.

Table 1: Level of use and gap in adoption of Elephant footyam technologies in study area

Crop operations	Improved package of practices	Farmers practices	Gap
Variety	Gajendra	Unknown local variety	Full gap
Soil testing	Have done in all locations	Not in practice	
Seed rate (kg/ha)	80 qt/ha	90 qt/ha	Partial gap
Availability of seed	Arrange seeds with help of district horticulture department of Varanasi.	Not easy available that why farmers used local seed.	
Seed treatment	Seed was treated by mancozeb @ 3% (3 gm/litter water), soaked for 30 minutes and dried in shade for 4 hours.	Not in practice	Full gap
Sowing method/ Spacing	Transplanting distance is 90 cm X 90 cm between plant to plant and row to row and pits size is 45 X 45 X 45 cm filled with 2 kg composed FYM and half top portion of soil.	Flat bed transplanting Row to Row 60 cm & Plant to Plant 45 cm.	Partial gap
sowing time	First week of March	June	Full gap
Fertilizer dose	250 qt, ha decomposed organic manure with Fertilizer @ 80 Kg N, 60 Kg P_2O_5 and 100 Kg K_2O/ha	Without recommendation	Partial gap
Weed management	By hand weeding, natural methods/05 weeding	Hand weeding/03 weeding	Partial gap
Insect, pest and disease management	No/injudicious use of and insecticides and fungicides		

Table 2: Productivity, technology gap, technology index and extension gap in elephant footyam under FLD

Year	Area (ha)	No. of farmer	Yield (q/ha)			% Increase in yield	Extension gap (q/ha)	Technology gap (q/ha)	Technology index (%)
			Potential	Demonstration	Control				
2012-13	1.0	08	650	485	360	34.72	125	165	25.38
2013-14	1.0	08	650	455	348	30.74	107	195	30.00
2014-15	1.0	08	650	504	383	31.59	121	146	22.46
Average	-	-	650	495.66	370	34.00	125.66	154.33	25.94

Control*= Farmers practice use as control

Table 3: Comparative economics of Elephant Foot yam under demonstrated and farmers practice

Year	Cost of Cultivation (Rs./ha)		Gross return (Rs./ha)		Net Returns (Rs./ha)		B:C Ratio	
	Demo.	Control*	Demo.	Control*	Demo.	Control*	Demo.	Control*
2012-13	86500	82600	485000	360000	398500	277400	4.16	3.35
2013-14	92600	90400	455000	348000	362400	255400	3.91	2.82
2014-15	100000	96500	504000	383000	385000	286500	3.85	2.96
Average	93033.33	89833.33	481333	363666	381966	273100	3.97	3.04

Control*= Farmers practice use as control

Table 4: Impact of Front Line Demonstration (FLDs) on adoption of Elephant foot yam production technology

Technology	Numbers of adopters		Change in No. of adopter	Impact (% Change)
	Before demonstration	After demonstration		
Land preparation and FYM applications	17	42	25	147.05
Recommended HYV	14	32	18	128.57
Seed rate	03	25	22	733.33
Seed treatment and sowing distance	12	34	22	183.33
Balance fertilizer application	06	24	18	300.00
Weed management	12	26	14	116.66
Spacing & plant populations	08	23	15	187.50
Recommended insect pest management	04	22	18	450
Overall impact				304.25

Table 5: Impact of Front Line Demonstration (FLDs) on horizontal spread of Elephant footyam

Variety	Area (ha)		Change in area (ha)	Impact (% Change)
	Before demonstration	After demonstration		
Gajendra	25.50	189.0	163.5	641.17

Elephant footyan corms

Demonstration plot of Elephant footyam

Elephant footyam as intercrop in guava orchard

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