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MANGO BASED FRUIT CROPPING- A TOOL TO COMBAT CLIMATE CHANGE.

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ABSTRACT:
Present investigation to study performance of different dryland fruit crops in different combinations and as a sole crop carried at Research farm, Horticulture section, College of Agriculture, Dhule during 2015-16 and 2017-18 to find out economically viable fruit crop combinations under dryland conditions for sustainable farm income. The fruit crops namely Mango (*Mangifera indica*L.), Custard apple (*Annona squamosa* L.), Aonla (*Emblica officinalis* L.), Jamun (*Syzigium cumini* L.) and Drumstick (*Moringa oleifera*), a perennial vegetable was planted in different combinations. The experiment was set in Randomized Block Design with eight treatments which were replicated five times. The treatments designated as module and were Module-1 i.e. (Mango+ Custard apple + Aonla +Drumstick), Module-2 (Mango + Custard apple + Aonla) and Module-3 (Mango + Custard apple + Jamun) along with sole of each crop. Yield was worked on the basis of mango equivalent yield and the same was used for working out economics. It was observed that the yields of all crops in combination were less as compared to their respective sole crop. However, cumulative yields were higher resulting in more returns per hectare. Among these modules, the Module-2(Mango + Custard apple + Aonla) recorded higher mango equivalent yield of 5.07 t/ha and12.44t/ha during 2015-16 and 2017-18 respectively and was significantly higher than the Module-and Module-3. The Module-2 also recorded the highest cost benefit ratio of 3.21 and 3.84 during 2015-16 and 2017-18 respectively, which was higher than the Module-1 and Module-3. Hence, Module-2 (Mango + Custard apple + Aonla) was found to be the most viable combination for dryland conditions because of its higher equivalent yield, net returns and benefit from the same unit of land.

Keywords: *Mixed fruit cropping, equivalent yield, module, dryland.*

INTRODUCTION:

The negative impacts of sole cropping systems (growing a single fruit crop over a unit of area), such as soil erosion and degradation, chemical contamination, loss of biodiversity and fossil fuel use (Giller *et al.* 1997, Griffon 1999 and Tilman *et al.* 2002) are now visualized. There is no insurance if the crop fails due to aberrant climatic conditions or outbreak of pest or diseases. This has reduced the sustainability and profitability of farming. It is, therefore, imperative to study the prospects of mixed fruit cropping system involving perennial and hardy fruit crop that would enable income security. The potentiality of crops like mango, custard apple, aonla, Jamun, etc. under dryland conditions as a sole crop is known however, their performance in mixed cropping needs to be studied. With this outlook the present investigation on mixed fruit cropping was undertaken to assess the performance of different fruit crop combinations involving Mango, Custard apple, Aonla, Jamun and Drumstick(a perennial vegetable crop) and to find out economically viable fruit crop module under dryland conditions.

MATERIAL AND METHODS:

The present field experiment was carried out during 2015-16 and 207-18 at Research Farm, Horticulture Section, College of Agriculture, Dhule,
Maharashtra (India). Fruit crops namely Mango (*Mangifera indica*, L.), Custard apple (*Annona squamosa* L.), Aonla (*Emblica officinalis* L.), Jamun (*Syzigium cumini* L.) and Drumstick (*Moringa oleifera*), a perennial vegetable were planted in different combinations, referred as

fruit crop module. These crops are well known dryland crops and have non-synchronous nature with different flowering and harvesting period which ensures a secure supply of income to the growers throughout the year.

In the present study, mango was planted at regular spacing of 10 m x 10 m and all other crops are planted in the interspaces in the mango. Among these crops, custard apple is common in all the three modules, aonla was planted in two modules *i.e.* Module-1 and Module-2, whereas drumstick and jamun were planted only in the Module-1 and Module-3, respectively.

The experiment was carried out in a Randomized Block Design (RBD) with eight treatments which were replicated five times and each treatment comprised of a unit of 1 (one) plant. The treatments were assigned randomly in each replication.

To evaluate the performance of the modules under study and to identify most suitable module for dryland conditions, the mango equivalent yield was worked out for different crops based on prevailing market prices as suggested by Thiruvvarssan, *et al.* (2014).

$$\textbf{Equivalent yield(tha}^{-1}\textbf{)} = \frac{\text{Yield of intercrop (tha}^{-1}\text{) x Market price}}{\text{Prevailing price of base (main) crop}}$$

Based on the yield of each component fruit crop in the module and cost of cultivation, economics were worked out in accordance with the prevailing market prices for all the modules for the year under study. Data generated were subjected to statistical analysis as per the method given by Panse and Sukhatme (1995).

Results and discussion

Yield (t plant^{-1})

As revealed from the Table1, combinations of different fruit crops *i.e.* modules had significant influence of on the yield. It is noted that maximum yield per hectare was registered in sole crop of each fruit crop in all the modules. Significantly the highest yield of 1.48 t ha^{-1}and3.60t ha^{-1}was recorded in Sole crop of mango (T_4) during 2015-16 and 2017-18, respectively. Among the modules, the maximum yield per hectare of 1.19 and4.35was registered in the treatment T_2 - (Module 2). In custard apple, significantly higher yield of 4.89 tha^{-1} and 4.07 tha^{-1}was observed in T_2 - (Module 2)during the years 2015-16 and 2017-18, respectively. In aonla, maximum fruit yield per hectare of 10.94 and 17.35 was observed in sole aonla crop (T_6) during 2015-16 and 2017-18, respectively. In jamun, the highest yield per hectare of 0.54 and 0.65 was observed in T_3 - (Module 3) during the year 2015-16 and 2017-18, respectively. In drumstick, maximum fruit yield of 7.44 t ha^{-1} and 8.07 t ha^{-1} was observed in sole drumstick (T_8), and the lowest yield (0.49 t ha^{-1}) was observed in T_1 -(Module 1) during both the years.

The decline in the fruit yield in module as compared to sole crop of mango was noticeable and similar trend was also observed in all the component crops. Higher yield (per ha) in sole crop might be due to higher per plant yield. The results are congruence with Moshiur Rahman *et al.* (2014) who reported decrease in yield in base crop of coconut and component fruit crops of litchi and sweet orange in multi-storied fruit garden.

(5) Mango Equivalent yield (t/ha)

As revealed from the Table 2, the treatment T_2 - (Mango + Custard apple + Aonla) registered significantly the highest equivalent yield of 5.07 t ha^{-1}and 12.44 t ha^{-1}during the year 2015-16 and 2017-18, respectively, which was significantly higher than the other modules. The next best module was T_1 - (Mango + Custard apple + Aonla + Drumstick) recording 3.04 t ha^{-1}and 3.69 t ha^{-}

[1]equivalent yield. The unsatisfactory performance of the Module-3 (Mango + Custard apple + Jamun) might be due to poor yield of Jamun fruit crop.

The results are in similar line with Moshiur Rahman *et al.* (2014) who reported higher equivalent yield of coconut than the sole crop in multi- storied fruit garden. Higher equivalent yield in all the modules might be due to contribution of the entire component crops for overall increase in the yield under multiple cropping systems. Shahapurmath *et al.* (2003) while studying the arecanut based cropping systems also reported enhancement in the yield of main crop of arecanut.

The present studies suggested that the yield of component fruit crops in mixed fruit cropping may be low as compared to sole crop, due sharing in space, light and food, but equivalent yield of base crop is more because of significant contribution of each component fruit crop. This is what expected in the mixed fruit cropping system not only for sustainability of yield, but also for economic sustainability of the farmer in dryland regions.

(6) Economics of mixed fruit cropping system

As apparent from the Table 2 that, among all these modules studied, the Module T_2 - (Mango + Custard apple + Aonla) had the significantly highest equivalent yield of 5.07 t $ha^{-1}$and 12.44 t ha^{-1}andrecorded the maximum net returns of Rs. 1,04, 784.00 $ha^{-1}$and Rs. 2,76,012 with cost benefit ratio of 3.21 and 3.84, during the year 2015-16 and 2017-18, respectively.

CONCLUSION:

All the modules of mixed cropping systems under study registered higher equivalent yield and were found to be economically better with increased net returns over and above the returns from sole crop. Baghel *et al.* (2003), and Swain and Padhi (2011) have also reported the profitability of mangobased cropping systems either by annual or perennial crops. The fruit crop module-2 i.e. T_2havingcombinations of Mango + Custard apple + Aonla resulted in increased productivity and profitability and hence was found to be the most feasible combination for dryland conditions owing to its higher equivalent yield and net returns during both the years consecutively. It can also be inferred from overall results that the mixed fruit cropping has potential to improve yield and generate more income also, as compared to sole or monocropping. Higher equivalent yield also suggest that failure one crop can be compensated by yield of other two crops in the mixed fruit cropping.

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Treatment	Treatment details
T_1	Module-I (Mango + Custard apple + Aonla + Drumstick)
T_2	Module-2 (Mango + Custard apple + Aonla)
T_3	Module-3 (Mango + Custard apple + Jamun)
T_4	Mango sole crop
T_5	Custard apple sole crop
T_6	Aonla sole crop
T_7	Jamun Sole crop
T_8	Drumstick sole crop

Table1. Treatment Details

Table 1. Yield (t ha^{-1}) of fruit indifferent fruit crops under modules (different crop combinations), and in sole crops (2015-16).

Treatments	Yield (t ha^{-1})				
	Mango	Custard apple	Aonla	Jamun	Drumstick
T_1- Module -1 (Mango+ Custard apple + Aonla+Drumstick)	0.93	0.75	2.32	--	0.49
T_2- Module -2 (Mango+ Custard apple + Aonla)	1.19	0.83	6.37	--	--
T_3- Module -3 (Mango+ Custard apple + Jamun)	0.83	0.86	--	0.54	--
T_4- Sole Mango	1.48	--	--	--	---
T_5- Sole Custardapple	--	4.89	--	--	--
T_6- Sole Aonl	--	--	10.94	--	--
T_7- Sole Jamun	--	--	--	0.51	--
T_8– Sole Drumstick	--	--	--	--	7.44
S.E. ±	0.02	0.04	--	--	--
CD at 5 %	0.06	0.13	--	--	--

Table 2. Yield per hectare (t/ha) different fruit crops under modules and in sole Crops (Year 2017-18).

Treatment	Yield per plant (t/ha)				
	Mango	Custard apple	Aonla	Jamun	Drumstick
T_1-Module-1 (Mango+ C. apple + Aonla + Drumstick)	3.75	3.69	5.11	--	0.91
T_2-Module -2 (Mango + C. apple+ Aonla)	4.35	4.30	11.37	--	--
T_3-Module -3 (Mango + C. apple +amun)	4.04	2.84	--	0.65	--
T_4- Sole mango	3.60	--	--	--	--
T_5- Sole custard apple	--	4.07	--	--	--
T_6- Sole Aonla	--	--	17.35	--	--

Table 3. Equivalent yield (t ha^{-1}) and Cost: Benefit ratio (2015-16).

Treatment	Mango equivalent yield (t/ha)	Cost of cultivation (Rs)	Gross monetary returns (Rs)	Net monetary returns (Rs)	CBR
T_1-Module-1(Mango+ C. apple + Aonla + Drumstick)	3.04	41,070	91,200	50,130	2.22
T_2-Module -2 (Mango + C. apple + Aonla)	5.07	47,316	1,52,100	1,04784	3.21
T_3-Module -3 (Mango + C. apple + Jamun)	2.09	35,606	62,700	27,094	1.76
T_4- Sole mango	1.48	23,180	44,400	28,220	1.91
T_5- Sole C. apple	4.89	55,000	1,22,250	91,750	2.22
T_6- Sole Aonla	10.94	80,800	1,64,100	1,03,300	2.03
T_7- Sole Jamun	0.51	10,000	15,300	5,300	1.53
T_8-Sole Drumstick	7.44	68,000	1,48,800	83,800	2.18
S.E.+	0.11	--	--	--	--
C.D at 5%	0.36	--	--	--	--

Table 4. Equivalent yield (t ha^{-1}) and Cost: Benefit ratio (Year 2017-18).

Treatment	Mango equivalent yield (t/ha)	Cost of cultivation (Rs)	Gross monetary returns (Rs)	Net monetary returns (Rs)	CBR
T_1-Module-1 (Mango+ C. apple + Aonla + Drumstick)	9.44	1,12,380	2,83,200	1,70,820	2.52
T_2-Module -2 (Mango + C. apple + Aonla)	12.44	97,188	3,72,200	2,76,012	3.84
T_3-Module -3 (Mango + C. apple + Jamun)	7.31	1,05,942	2,19,300	1,13,258	2.07
T_4- Sole mango	3.60	54,271	1,08,000	53,729	1.99
T_5- Sole custard apple	4.07	54,267	1,22,100	67,833	2.25
T_6- Sole Aonla	17.35	85,049	1,75,500	88,451	2.04
T_7- Sole Jamun	0.38	5,390	7,600	2,210	1.41
T_8-Sole Drumstick	8.07	37,018	80,700	43,682	2.18
S.E.+	0.18				
C.D at 5%	0.53				