

# Productivity and economics of Ber based Agri-Horticultural systems under semi-arid condition of Akola in Vidarbha

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## ABSTRACT

Alternate land use system is applicable in areas where subsistence farming is practiced in unstable ecosystems, and it poses more potentiality and flexibility in land use than the traditional crop production systems. Alternate land use systems are effective means of stabilizing both productivity of dryland crops and incomes of dryland farmers, besides generating more counter potential. Ber is highly resistant to drought conditions due to well-developed long tap root system than other crops. There is area to grow field crops in between the interspaces during the early growth stages of Ber in order to increase the land use efficiency. The experiment with objectives for studying the productivity and the economics of Ber based Agro-Horticulture system under dryland condition was conducted at the research farm of the AICRP for Dryland Agriculture, Dr. PDKV, Akola. The experiment was conducted in Randomized Block Design with four treatments and five replications. The six years pooled data resulted that the treatment cotton + soybean (1:1) recorded significantly highest Ber equivalent yield ( $970 \text{ kg ha}^{-1}$ ), gross monetary returns (Rs. 69643), net monetary returns (Rs.22106) and rainwater use efficiency ( $1.17 \text{ kg ha}^{-1} \text{ mm}^{-1}$ ) as compare to rest of the treatments..

*Keywords: Agri horticulture, Ber, Intercropping, Soybean, Cotton, GMR, NMR*

## 1. INTRODUCTION

The ever-growing pressure of human and animal population and the transforming food habits have led to intensive cultivation of marginal lands leading to land degradation intensely under rainfed conditions. The partial arid regions with minimal intensity rainfall and poor soil coat produce high substance per unit area (Ramamohan Reddy et al., 2013). The areas predominant with monoculture and traditional agricultural practices frequently lead to below-average agriculture productivity. To make best use of these lands, there is need to plan land use based on its supporting ability keeping in view the short-term goals of market demands, profitability and the long-term goal of sustainability. The extent of human pressure and the effects of conflicting land use systems need to be addressed. Catchment area can be envisioned based on the landscape/ topography and is the idea for designing in-situ conservation formations for water management (Patode et al. 2017). The Alternate land use system is appropriate in areas where subsistence farming is practiced in fragile ecosystems, and it poses more potentiality and flexibility in land use than the traditional crop production systems. An ideal system for dry land areas should have a judicious mix of crops, trees and grasses only then the natural resources will be judiciously utilized and returns maximized without any detrimental effects on environment (Narain, 2008). The alternate land use systems are surer means of stabilizing both productivity of dryland and incomes of dryland

farmers, besides generating more complement potential. Day by day demand for food fodder and fuel is growing, which could be solved by selecting suitable land use system, improvement of degraded, marginal and sub-marginal lands (Gupta et al., 2019). The most **water efficient horticulture** crops having multiple uses can be grown in association with annual crops with less or no competition and in some cases synergistic relationship was also observed (Pareek, 1999; Pareek and Awasthi, 2008; Bhandari et al., 2014; Singh et al., 2017 and Tanvar et al., 2018). Ber is planted with wider spacing of 6 m and the inter row spacing provides conditions for growing of field crops. Ber is very hardy **in nature and resistance** to drought conditions due to well-developed long tap root system than other perennial components (Meena, 2015 and Meena et al., 2019). To increase the land use efficiency, there is scope for growing field crops during initial growth stages of Ber in between the inter spaces. Ber needs pruning every year which is usually done in April/May, and it takes about four to five months to develop full canopy during this period annual crops can be grown in the inter row space (Yaragattikar and Itnal, 2003). In view of this, the present investigations were carried out **with** the objective to study the productivity and the economics of Ber based Agro-Horticulture system under dryland condition.

## 2. MATERIAL AND METHODS

The present investigation was carried out at research farm of All India Coordinated Research Project for Dryland Agriculture (AICRPDA), Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra) during the year 2016-17 to 2021-22 under rainfed conditions. Akola is situated at 20° 42' North latitude and 77° 02' East longitude and lies in subtropical continental climate at 307.4 meters above the mean sea level. The experimental soil was clayey in texture. **with** slightly alkaline in nature (pH- 7.85), low in organic carbon content (5.17 g kg<sup>-1</sup>), available nitrogen (230.8 kg ha<sup>-1</sup>), available phosphorus (18.5 kg ha<sup>-1</sup>) and high in available potassium (330.6 kg ha<sup>-1</sup>).

The experiment was conducted in Randomized Block Design **with** four treatments and replicated five times. The treatments comprised of sole cotton, sole soybean, cotton + soybean (1:1) intercropping system and cotton + soybean (3:3) strip cropping. Cotton crops were sown under high density planting in sole as well as in intercropping. Cotton cv. AKH 081 **is a short duration variety** which is suitable for high density planting. Soybean cv. was JS 335. The **row spacing for** sole cotton, sole soybean and intercropping **is** 45 cm. The intra row spacing in soybean was 5 cm and in cotton 10 cm. The sole cotton was fertilized with 60:30:30 NPK kg ha<sup>-1</sup>, soybean with 30: 75:30 NPK kg ha<sup>-1</sup>. Cotton + soybean (1:1) intercropping and Cotton + soybean (3:3) strip cropping was fertilized with 50:55:30 NPK kg ha<sup>-1</sup>. The plantation of Ber **variety Mehrun** was done on 6 m x 6 m spacing and the cropping was done on 4.05 m. **wide** alley. Row wise intermittent trenches were prepared in between two plants. Every year pruning was done in the month of April/ May. The rainfall data of the experimental period is given in Table 1.

**Table 1. Rainfall data from 2016-17 to2021-22**

<b>Rainfall</b>	<b>2016-17</b>	<b>2017-18</b>	<b>2018-19</b>	<b>2019-20</b>	<b>2020-21</b>	<b>2021-22</b>
Rainfall (June to Sept)	741.8	455.3	830.1	817.9	733.6	968.0
Rainy days	40	38	41	47	49	50
Rainfall (Oct. to Dec.)	90.5	62.0	4.5	111.1	38.0	116.0
Rainy Days	05	05	1.0	10	04	04
Total Rainfall (June – Dec)	832.3	517.3	834.6	929.0	771.6	1084.0
RD	45	43	42	57	53	54

**Choice of fruit tree:** It is generally preferred to grown multipurpose tree spp. which can cater domestic needs apart from tree fodder during the off season. Ber not only provide

additional income, employment and nutritious fruits for balanced diet but also help in harvesting side branches for fodder or fencing purpose. It is fast growing, multipurpose, tolerant to drought, extremes temperature and propitiate easily. It can be grown even on marginal land or inferior soil where most other fruit trees either fail to grow or give very poor performance and can give good production even under rainfed conditions. It can be grown on a variety of soils and climatic conditions ranging from sub tropical to tropical. However, its systematic plantations arc sporadic. The Ber fruits are rich in vitamin C and sugar with fair number of mineral constituents. Ber is richer than apple in protein, phosphorus, calcium, carotene and vitamin C and excel oranges in phosphorus, iron, vitamin C, calorific values and carbohydrates (Meghwal et al.. 2007).

### 3. RESULTS AND DISCUSSION

#### 3.1 Seed cotton and cotton stalk yield, Soybean seed and straw yield

During the years 2016-17, 2017-18, 2018-19, 2019-20, 2020-21,2021-22 and mean of six years, results showed that, the sole cotton and sole soybean crops recorded maximum yield than the intercropping and strip intercropping system. It was because plant population of the crop was more in sole cropping than the intercropping and strip cropping system (Table 2). Similar trend was observed in respect of cotton stalk and soybean straw yield during the period of experimentation (2016-17 to 2021-22). In a rainfed system, intercropping of one row of soybean (JS 335) between cotton rows recorded the highest mean soybean grain yield (Sankarnarayan et al. 2010).

**Table 2. Seed cotton yield, stalk yield of cotton, soybean seed and straw yield as influenced by the various treatments (2016-17 to 2021-22)**

Treatments	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	Mean
	<b>Seed Cotton Yield (kg ha<sup>-1</sup>)</b>						
T <sub>1</sub> : Sole Cotton	1271	608	685	744	658	622	607
T <sub>2</sub> : Sole soybean	-	-	-	-	-	-	-
T <sub>3</sub> : Cotton + Soybean (1:1)	699	302	545	539	454	308	388
T <sub>4</sub> : Cotton + Soybean (3:3)	844	365	518	476	442	422	391
<b>Soybean Seed Yield (kg ha<sup>-1</sup>)</b>							
T <sub>1</sub> : Sole Cotton	-	-	-	-	-	-	-
T <sub>2</sub> : Sole soybean	756	556	1307	572	614	621	738
T <sub>3</sub> : Cotton + Soybean (1:1)	483	288	870	385	411	302	457
T <sub>4</sub> : Cotton + Soybean (3:3)	638	241	666	305	324	328	417
<b>Cotton Stalk Yield (kg ha<sup>-1</sup>)</b>							
T <sub>1</sub> : Sole Cotton	1000	446	722	631	630	553	664
T <sub>2</sub> : Sole soybean	0	0	0	0	0	0	0
T <sub>3</sub> : Cotton + Soybean (1:1)	536	232	537	356	461	456	430
T <sub>4</sub> : Cotton + Soybean (3:3)	713	246	504	325	366	384	423
<b>Soybean Straw Yield (kg ha<sup>-1</sup>)</b>							

T <sub>1</sub> : Sole Cotton	-	-	-	-	-	-	-
T <sub>2</sub> : Sole soybean	860	663	1785	587	872	751	920
T <sub>3</sub> : Cotton + Soybean (1:1)	372	365	944	363	673	535	542
T <sub>4</sub> : Cotton + Soybean (3:3)	458	323	696	297	542	512	471

### 3.2 Ber yield (kg ha<sup>-1</sup>)

During the years 2016-17, 2020-21 and 2021-22, Ber yield was higher in Ber + sole cotton treatments. During the year 2017-18, Ber yield was higher in treatment of Ber + cotton + soybean (1:1) intercropping system. Treatment of Ber + sole soybean recorded higher yield of Ber during 2018-19 and 2019-20 (Table. 3). Mean data of six year showed that treatment of Ber + sole soybean recorded higher Ber yield and followed by Ber + cotton +soybean (1:1) intercropping system.

**Table 3. Ber yield (kg ha<sup>-1</sup>) as influenced by different treatments**

Treatments	Ber yield (kg ha <sup>-1</sup> )						Mean
	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	
T1 : Sole Cotton	526	77	647	343	387	365	334
T2: Sole soybean	496	71	796	362	302	354	394
T3: Cotton + Soybean (1:1)	458	80	722	329	296	353	379
T4: Cotton + Soybean (3:3)	468	69	611	314	298	349	354

### 3.3 Ber equivalent Yield (kg ha<sup>-1</sup>)

The data regarding Ber equivalent yield is presented in Table 4. During the year 2016-17, Ber equivalent yield was observed significantly higher in treatment of Ber + Cotton + soybean (3:3) which was at par with Ber + sole cotton (1319 and 1267 kg ha<sup>-1</sup> respectively). During the year 2017-18, treatment of Ber + sole cotton recorded significantly higher Ber equivalent yield and being at par with Ber +cotton + soybean (1:1) and Ber + cotton + soybean (3:3) strip intercropping system. Significantly highest Ber equivalent yield (1645 and 915 kg ha<sup>-1</sup>) was recorded in Ber +cotton + soybean (1:1) intercropping system during 2018-19 and 2019-20. During the year 2020-21, Ber +cotton + soybean (1:1) treatments recorded higher Ber equivalent yield of 880 kg ha<sup>-1</sup> which was at par with Ber + sole cotton (869 kg ha<sup>-1</sup>) but significantly to rest of the treatments. Treatment of Ber + sole cotton recorded significantly higher Ber equivalent yield (900 kg ha<sup>-1</sup>) and being at par in the Ber + cotton + soybean (3:3) strip intercropping system than rest of the treatments.

The pooled data of six year for Ber equivalent yield showed that treatment of Ber +cotton + soybean (1:1) recorded significantly highest value (970 kg ha<sup>-1</sup>) than the other treatments. Among cotton based intercropping systems, maximum cotton equivalent yield was attained under cotton + soybean (1:1) (Chary et al., 2014).

**Table 4. Ber equivalent yield (kg ha<sup>-1</sup>) as influenced by various treatments**

Treatments	Ber equivalent yield (kg ha <sup>-1</sup> )						
	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	Mean
T1 : Sole Cotton	1267	431	1191	824	869	900	856
T2: Sole soybean	923	385	1534	685	649	704	810
T3: Cotton + Soybean (1:1)	1138	418	1645	915	880	789	970
T4: Cotton + Soybean (3:3)	1319	418	1397	751	761	897	926
S.Em. ±	18.5	7.37	20.97	22.7	17.2	7.76	7.43
C.D. (P=0.05)	56.1	22.4	63.6	68.8	52.1	23.5	22.55

### 3.4 Economics

#### 3.4.1 Gross monetary returns

The data regarding gross monetary and net monetary returns is presented in Table 5. During the year 2016-17, treatment Ber + cotton + soybean (3:3) strip cropping system recorded higher gross monetary returns (Rs. 94681ha<sup>-1</sup>) and being at par with Ber + sole cotton (Rs. 91212 ha<sup>-1</sup>) but significantly to rest of the treatments. During the year 2017-18, significantly higher gross monetary returns (Rs. 31259 ha<sup>-1</sup>) was recorded in Ber + sole cotton and on par with Ber + cotton + soybean (1:1) intercropping system and Ber + cotton + soybean (3:3) strip cropping system. Significantly highest gross monetary returns were recorded in treatment Ber + cotton + soybean (1:1) intercropping system during the season of 2018-19 and 2019-20. Treatment Ber + cotton + soybean (1:1) intercropping system recorded higher gross monetary returns (Rs. 63622 ha<sup>-1</sup>) and being at par with Ber + sole cotton (Rs. 62419 ha<sup>-1</sup>) during 2020-21. During the season of 2021-22, significantly higher gross monetary returns were recorded with treatment of Ber + cotton + soybean (3:3) and comparable with Ber + sole cotton than other treatments. Pooled mean data showed that the significantly highest gross monetary returns (Rs. 69643 ha<sup>-1</sup>) was recorded in treatment of Ber + cotton + soybean (1:1) intercropping system. Soybean intercropping in cotton gave a higher gross monetary return per hectare ( Sankarnarayan et al., 2010).

**Table 5. Gross monetary returns as influenced by various treatments**

Treatments	Gross Monetary Returns (Rs.ha <sup>-1</sup> )						
	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	Pooled mean
T1 : Sole Cotton	91212	31259	85165	59233	62419	64368	61610
T2: Sole soybean	65657	27748	109615	48685	46499	50250	57849
T3:Cotton+Soybean(1:1)	81440	30309	117695	65368	63622	57064	69643
T4:Cotton+Soybean(3:3)	94681	30257	99927	53752	54832	64394	66472
S.Em. ±	1285	523	1451	1586	1240	540	527
C.D. (P=0.05)	3898	1586	4401	4812	3761	1637	1599

### 3.4.2 Net monetary returns

During the year 2016-17, treatment of Ber + cotton + soybean (3:3) strip cropping system resulted in significantly higher net monetary returns (Rs. 46809 ha<sup>-1</sup>) and being at par with Ber + sole cotton (Rs. 45716 ha<sup>-1</sup>) than other treatments. Treatment of Ber + sole soybean recorded significantly higher net monetary returns of Rs. 70370 ha<sup>-1</sup> and comparable with Ber + cotton + soybean (1:1) intercropping system than rest of the treatments during the season of 2018-19. During 2019-20, net monetary returns recorded higher in treatment of Ber + cotton + soybean (1:1) system and found at par with Ber + sole cotton than other treatments. Net monetary returns were found significantly higher during 2020-21 in treatment of Ber + sole cotton and found to be comparable with Ber + cotton + soybean (1:1) system than other treatments. During the season 2021-22, treatment of Ber + sole cotton recorded significantly highest net monetary returns of Rs. 20312 ha<sup>-1</sup> (Table 6). Pooled mean data regarding net monetary returns showed that, significantly highest net monetary returns of Rs. 22106 ha<sup>-1</sup> was recorded in treatment of Ber + cotton + soybean (1:1) intercropping system. Chary et al. (2014) reported that under semi-arid Vertisols at Akola, among different intercropping systems, mean maximum net returns was attained by cotton + soybean (1:1) system.

**Table 6. Net monetary returns (Rs. ha<sup>-1</sup>) as influenced by various treatments**

Treatments	Net monetary returns (Rs. ha <sup>-1</sup> )						
	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	Pooled mean
T1 : Sole Cotton	45716	-11525	41055	15555	18735	20312	17644
T2: Sole soybean	27155	-10484	70370	10432	8189	11931	19250
T3:Cotton+Soybean(1:1)	33311	-15943	68870	17635	15974	10169	22106
T4:Cotton+Soybean(3:3)	46809	-17541	50176	5508	6454	15429	17587
<b>S.Em. ±</b>	<b>1285</b>	<b>523</b>	<b>1451</b>	<b>1586</b>	<b>1240</b>	<b>540</b>	<b>527</b>
<b>C.D. (P=0.05)</b>	<b>3898</b>	<b>1586</b>	<b>4401</b>	<b>4812</b>	<b>3761</b>	<b>1637</b>	<b>1599</b>

### 3.4.3 B:C ratio

The mean data regarding the benefit cost ratio of six seasons presented in Table 7 and revealed that treatment of Ber + sole soybean recorded maximum value of B:C ratio (1.50) followed by Ber + Cotton + Soybean (1:1) intercropping (1.46) than rest of the treatments.

**Table 7. B:C ratio as influenced by various treatments**

Treatments	B:C Ratio						
	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	Mean
T1 : Sole Cotton	2.00	0.73	1.93	1.36	1.43	1.46	1.40
T2 : Sole soybean	1.71	0.73	2.79	1.27	1.21	1.31	1.50
T3 : Cotton + Soybean (1:1)	1.69	0.66	2.41	1.37	1.34	1.22	1.46
T4 : Cotton + Soybean (3:3)	1.98	0.69	2.01	1.11	1.13	1.32	1.36

### 3.5 Rainwater Use Efficiency (kg ha<sup>-1</sup>mm<sup>-1</sup>)

The data regarding rainwater use efficiency is given in Table 8. In respect of rainwater use efficiency, treatments of Ber + Cotton + Soybean (3:3) recorded maximum rainwater use efficiency (1.59kg ha<sup>-1</sup>mm<sup>-1</sup>) and followed by Ber + sole cotton (1.52kg ha<sup>-1</sup>mm<sup>-1</sup>) during

2016-17. During 2017-18, rainwater use efficiency was found maximum in treatment of Ber + sole Cotton followed by Ber + Cotton + Soybean (1:1) and similar value observed in Ber + Cotton + Soybean (3:3) strip cropping. Treatment of Ber + Cotton + Soybean (1:1) recorded maximum value of RWUE during 2018-19 and 2019-20. During the year 2020-21, rainwater use efficiency was recorded maximum in Ber + Cotton + Soybean (1:1) and followed by Ber + sole Cotton. Similar value of RWUE (0.83kg ha<sup>-1</sup>mm<sup>-1</sup>) was observed in treatment of Ber + sole Cotton and cotton + soybean (3:3) strip cropping. Mean of six-year data showed the higher value of RWUE was recorded in Ber + Cotton + Soybean (1:1) followed by Ber + Cotton + Soybean (1:1) and Ber + sole Cotton. **Similar results were observed by Chary et al. (2014).**

**Table 8. Rainwater Use Efficiency (kg ha<sup>-1</sup>mm<sup>-1</sup>) as influenced by various treatments**

Treatments	Rainwater Use Efficiency (kg ha <sup>-1</sup> mm <sup>-1</sup> )						Mean
	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	
T1: Sole Cotton	1.52	0.83	1.43	0.89	1.13	0.83	1.10
T2: Sole soybean	1.11	0.74	1.84	0.74	0.84	0.65	0.99
T3:Cotton+Soybean (1:1)	1.37	0.81	1.97	0.98	1.14	0.73	1.17
T4:Cotton+Soybean (3:3)	1.59	0.81	1.67	0.81	0.99	0.83	1.11

#### 4. CONCLUSION

On the basis of six years of experimental findings, it can be concluded that, under Agri-horticultural system of Ber (6x6 m) intercropped with HDPS American cotton (AKH-081) + soybean (1:1) with fertilizer level of (50:55:30 NPK kg ha<sup>-1</sup>) recorded highest Ber equivalent yield, Gross monetary returns, Net monetary returns and rainwater use under rainfed conditions.

#### Acknowledgment

The authors are thankful to the Director and Project coordinator, ICAR-CRIDA, Hyderabad, Government of India for their facilities and support under AICRP for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

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