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Zero budget natural farming (ZBNF): A critical analysis on crop wise practices, ZBNF models and cropping systems

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Abstract
This study was conducted in Vizianagaram district of Andhra Pradesh. In Vizianagaram district, the major crops grown under ZBNF were Paddy, Maize, Cotton, Green gram, Black gram, Brinjal, Bendi, Mango and other crops were grown under small proportions. Most of the ZBNF practices were applicable to more than one crop with multiple uses of kashayams and asthras for prevention and control of several pests and diseases in various crops. More than three fifth of the ZBNF farmers (65%) have adopted kitchen garden model in their back yard. Majority (85%) of the ZBNF farmers followed paddy, maize and pulse cropping pattern followed by paddy, maize and vegetables cropping system as expressed by 75% farmers.

Keywords: ZBNF, ZBNF models, crop wise practices under ZBNF, cropping systems under ZBNF

Introduction
Agriculture is the backbone of the Indian economy where more than 70% of population depends on agriculture directly and indirectly contributing 20.5% share to Gross Domestic Product. After green revolution, Indian agriculture changed from the state of subsistence to commercial and production of food grains increased extremely to meet the requirements of growing population needs. In other hand, after green revolution, usage of chemicals like fertilizers and pesticides are increased leading to high input cost, loss of soil fertility and increased accumulation of chemical residues in soils drastically. In this view, there is an immediacy for sustainable development of agriculture to feed the growing population. Zero Budget Natural Farming (ZBNF) is an alternative solution to above situation in current agricultural practices.

Zero Budget Natural Farming (ZBNF) practices include crop rotation, multistoried cropping, green manuring, preparation of kashayams, asthras, biological pest control etc. Beejamrutham, jeevamrutham, acchadana/mulching, waaphasa/moisture popularly known as four pillars of ZBNF. Zero Budget Natural Farming (ZBNF) is a "triple-win opportunity as it enhances crop productivity by reducing input costs and helps farmers increase their net income inducing climate resilient agriculture" (Sathiya Raj *et al*., 2020). Zero Budget Natural Farming suits all crops in all agro-climatic zones. Practices mean the practices which are adopted in growing the crop in entair crop life cycle.

Materials and Methods
Ex-post facto research design was taken for the investigation. This design was considered appropriate as the phenomena in the study has already been occurred. The state of Andhra Pradesh was chosen for the study as it is a leading state in Zero Budget Natural Farming. About 5,80,000 farmers were practicing ZBNF in 2,60,000 ha. in 3011villages throughout the Andhra Pradesh. Vizianagaram district was selected purposively as it was the prime district having ZBNF with highest area i.e., 38000 hectares and about to get saturation with this farming. Four mandals viz, Gumma Lakshmi puram (G.L. Puram), Vepada, Kurupam and Garugubilli were selected purposively in which the number of Zero Budget Natural Farming respondents were more. Two villages from each mandal, obtaining eight villages from four mandals (2 X 4 = 8) were selected by using simple random sampling technique. The details of selected villages were furnished in flow chart below. The sample includes 80 ZBNF farmers selected by employing simple random sampling method.

In Vizianagaram district, The major crops growing under ZBNF were Paddy, maize, cotton, green gram, black gram, brinjal, bendi, mango and other crops in small proportions. An open ended schedule was constructed to obtain list of crops grown under ZBNF.

ZBNF model was operationally defined as the combination of different crops grown in a certain area by adopting ZBNF practices by the respondents. Different models present in ZBNF were five layered model, seven layered model, Kitchen garden model, Sun model and Annapurna half acre model. Except Annapurna model, all models were adopted by the farmers. Here frequency and percentages were used to analyse the responses of farmers.

Cropping systems under ZBNF was operationally defined as the order in which the crops were grown or cultivated on a piece of land over fixed period by ZBNF farmers. The schedule was developed to study the cropping systems followed by ZBNF farmers. The frequencies and percentages were used to analyse the responses of the farmer.

Results and Discussion

Documentation of crops and crop wise ZBNF practices

In Vizianagaram district, the major crops grown under ZBNF were Paddy, Maize, Cotton, Green gram, Black gram, Brinjal, Bendi, Mango and other crops were in small proportions. In this study major crops grown under ZBNF and major crop wise ZBNF practices followed by the farmers were documented, listed and analysed in table 1.

A clear perusal from the table 1, shows that 96.66% ZBNF Paddy farmers were following seed treatment with beejamrutha and jeevamrutham followed by 93.33% spraying of panchagavya, agnastra and neemastra; 86.67% with neem oil; 83.33% follows alleyways formation and green manure incorporation; 80% application of asafoetida solution and buttermilk solution; 76.67% growing azolla and 70% farmers were applying maredupatra kashayam in their paddy fields.

Cent percent of the farmers were practicing seed treatment with beejamrutha and application of panchagavya in Maize followed by 96% spraying brahmasthra, 92% spraying agnasthra, 84% spraying datura kashayam and sown sorghum as a trap crop with maize and 80% inserted sticky traps in their maize fields. These traps were made by the farmers themselves by using oil cans with castor oil coating.

Majority of Cotton farmers (100%) were practicing application of ghana jeevamrutham, dhrava jeevamrutham, agniasthra and neemasthra followed by 90% applying panchagavya and sown castor or marigold as trap crops along with cotton, 80% sowing red gram as a inter crop along with the cotton and installed light traps, 75% applied NADEP compost, spraying gobar solution and vavilaku kashayam.

The farmers cultivated Green gram, practiced seed treatment with beejamrutha and applied 5% neemasthra 100 percent followed by 86.95% applying fermented buttermilk and giving two light irrigations and 82.61% applying 1 percent neem oil.

Majority of the farmers (96.3%) who were growing Black gram, practiced seed treatment with beejamrutha followed by 92.59% applied 1 percent neem oil; 88.89% spraying5 percent neem oil, buttermilk solution and giving two light irrigation and 83.33% spraying asafoetida and gobar solution.

Majority of the farmers growing Brinjal shown cent percent implemented seed treatment with beejamrutha, applied agnasthra and 5 percent neem oil solution; 93.33% given irrigation before harvesting and installed pheromone traps and 80% farmers applied neem powder in their brinjal field.

Table 1: Crops and crop wise pure ZBNF practices and RYSS mediated ZBNF practices (N=80)

S. No.	Name of the Practice	Remarks	F	%
Paddy and its practices followed by the farmers under ZBNF: (n=60)				
Pure ZBNF practices				
1.	Seed treatment with Beejamrutha	Helps to increase the resistance capacity of seedlings towards pests and diseases.	58	96.66
2.	Application of pond soil	Fifteen to twenty cart loads of pond soil per acre to the main field once in three years. If applied, it helps to increase the soil moisture holding capacity	40	66.67
3.	Incorporation of green manure crops	Helps to increase the soil organic matter and soil fertility.	50	83.33
4.	Growing azolla	Application of Azolla 4 kg/acre helps to fix 30-40 kg nitrogen per acre.	46	76.67
5.	Application of Jeevamrutham	Application of 500 lts/acre helps to increase the number of microorganisms in the soil.	58	96.66
6.	Application of Asafoetida solution	Helps to correct nutrient deficiencies of Iron, Zinc and Potassium.	48	80
7.	Application of Neemasthra	Twice in 15 days intervals. If applied, it controls sucking pests.	56	93.33
8.	Application of Agniasthra	Twice in 7 days intervals as a precautionary measure for stem borer.	56	93.33
9.	Application of Neem oil	One to two lts per acre for the control of Brown plant hopper.	52	86.67
10.	Application cow urine and buttermilk solution	Application of 10% buttermilk solution for the control of rice blast disease.	48	80
11.	Application of Maredupathra kashayam	Helps for rice blast control.	42	70
12.	Application of Asafoetida and gobar solution	As a precautionary measure to control Stem rot, Blast, Bacterial leaf blight.	40	66.67
13.	Application of Panchagavya	For higher yields and improvement of grain quality	56	93.33
	RYSS mediated ZBNF practices			
14.	Formation of alleyways	At the rate of 1 for each 2 mts helps to control the incidence of Brown Plant Hopper(BPH) and Green Leaf Hopper (GLH)	50	83.33
Maize and its practices followed by the farmers under ZBNF: (n=50)				
Pure ZBNF practices				
1.	Seed treatment with Beejamrutha	Helping to increase the resistance capacity towards pests and diseases.	50	100
2.	Application of manure	Application of FYM @ 5 t/ac, NADEP 2500 kg/ac, (at the time of ploughing). Application of Ghana jeevamrutham @250 kg/ac twice (125kg/ac each) in 30 days interval and application of dravajeevamrutham twice (200 lts /ac each).	30	60
3.	Spraying of Datura kashayam	Thirty DAS if there is high incidence of sucking pests.	42	84

4.	Application of Panchagavya	Thirty DAS for higher yields and improvement of grain quality.	50	100
5.	Spraying of Brahmastra	Three lts/ac for control of stem borer	48	96
6.	Spraying of Agniastra	At the rate of 3 lts/ac 40 DAS for the control of Fall army worm.	46	92
RYSS mediated ZBNF practices				
7.	Inserting sticky traps	At the rate of 15-20 per acre. For the control of maize stem borer. These traps were made by the farmers themselves by used oil cans with castor oil coating.	40	80
8.	Sowing Sorghum as trap crop	Sowing sorghum crop and removal of it 45 DAS for the control of maize stem borer.	42	84
Cotton and its practices followed by the farmers under ZBNF: (n=40)				
Pure ZBNF practices				
1.	Application of Ghana jeevamrutham	At the rate of 125 kg/ac in last puddling and 125 kg/ac at 60 DAS. Helps to increase the number of microorganisms in the soil, increases earthworm activity and enhances nutrient content in the soil.	40	100
2.	Application of NADEP compost	Two thousand five hundred kg/ac, (at the time of ploughing) improves soil properties, provides nutrients in a stable organic form.	30	75
3.	Application of Dhravajeevamrutham	Two hundred lts/ac at 30 DAS and 200 lts/ac at 75 DAS.	40	100
4.	Application of Panchagavya	At the rate of 3 lts/ac at 15 days interval helps to prevent the dropping of flowers and improves the yields and quality too.	36	90
5.	Spraying of asafoetida and gobar solution	Spraying of asafoetida and gobar solution @100 lts per acre for the control of bacterial and fungal diseases in cotton.	30	75
6.	Brahmastra/ agniastra	Spraying of brahmastra/ agniastra @ 3 lts/ac for the control of boll worms and Spodoptera.	40	100
7.	Vavilaku kashayam	Spraying of vavilaku kashayam @ 5 lts/ac at 80 DAS for sucking pests control.	30	75
RYSS mediated ZBNF practices				
8.	Inter crop	Sowing red gram along with cotton as inter crop in 1:4 (Red gram: Cotton) ratio	32	80
9.	Trap crop	Growing castor or Marigold as a trap crop: At the rate of 1:25 (castor or Mari gold: Cotton) ratio.	36	90
10.	Insertion of light traps	Insertion of light traps in the evening from 6 pm to 8:30 pm for sucking pest control	32	80
11.	Sticky traps	Installation of yellow sticky traps @ 20-25 per acre for the control of white fly. These traps were made by the farmers themselves by used oil cans with castor oil coating.	25	62.5
12.	Bird perches	Installation of Bird perches @ 15-20 per acre at 45 DAS.	28	70
13.	Pheromone traps	Installation of pheromone traps @ 4-5 per acre for the control of pink boll worm and Spodoptera.	20	50
Green gram and its practices followed by the farmers under ZBNF (n=46)				
Pure ZBNF practices				
1.	Seed treatment with Beejamrutha	Helps to increase the resistance capacity of seedlings towards pests and diseases.	46	100
2.	Application of FYM	Application of FYM 5t/acre, NADEP compost 2500 kg/ac and 100 kgs/ac of ghanajeevamrutham.	20	43.48
3.	Giving two light Irrigations	First irrigation at 25-30 DAS and second irrigation at 45-50 DAS.	40	86.95
4.	Spraying of 5% neemasthra	Twice in a week interval for the control of Flea beetles and white flies.	46	100
5.	Spraying of 1% Neem oil	Twice in one week interval for the control of thrips.	38	82.61
6.	Spraying fermented butter milk	Spraying buttermilk solution @ 6 lts/ac for the control powdery mildew and cercospora leaf spot.	40	86.95
7.	Vavilaku kashayam	Spraying of 5% vavilaku kashayam for the control of thrips.	26	56.5
RYSS mediated ZBNF practices				
8.	Pheromone traps	Installation of pheromone traps @ 5 per acre to control the spodoptera.	26	56.5
9.	Sowing Rhizobium treated seeds	Sowing Rhizobium treated seeds @ 200 gms for 10 kg seed for high yields.	28	68.87
Black gram and its practices followed by the farmers under ZBNF (n=54)				
Pure ZBNF practices				
1.	Seed treatment with Beejamrutha	Helps to increase the resistance capacity of seedlings towards pests and diseases.	52	96.3
2.	Giving two light Irrigations	First irrigation is before 30 DAS and second irrigation at 55 DAS for higher yields.	48	88.89
3.	Spraying of 5% neemasthra	Twice in one week interval for the control of Flea beetles, white flies, leaf crinkle and yellow mosaic also.	48	88.89
4.	Spraying of 1% Neem oil	Twice in one week interval for the control of thrips.	50	92.59
5.	Spraying fermented butter milk	Spraying buttermilk solution @6 lts/ac for the control of powdery mildew and cercospora leaf spot.	32	59.25
6.	Spraying of Asafoetida and gobar solution	Spraying two times in 10 days interval for the control of Anthracnose.	45	83.33
7.	Spraying of milk solution	Spraying 5% milk solution twice in a week interval for the control of yellow mosaic virus.	48	88.89
Brinjal and its practices followed by the farmers under ZBNF (n=30)				
Pure ZBNF practices				
1.	Seed treatment with beejamrutha	Helps to increase the resistance capacity of seedlings towards pests and diseases.	30	100
2.	Incorporation of FYM	Incorporation of 8-10 t/acre while ploughing	18	60
3.	Irrigation before harvesting	Providing 1-2 irrigations before harvesting of brinjal in summer for prevention of sour taste in fruits.	28	93.33
4.	Application of neem powder	Application of 1-2 quintals of neem powder per acre for controlling of nematodes in soil.	24	80
5.	Vavilaku kashayam	Spraying vavilaku kashayam @ 5 lts/ac for the control of spodoptera and aphids	22	73.33
6.	Spraying agniasthra	Spraying agniasthra @ 3 lts/ac for the control of fruit and shoot borer	30	100
7.	Application of 5% neemastra	Spraying of Neemastra at every 20 days interval for the control of epilachna beetle and sucking insects.	30	100

8.	Spraying of asafoetida and gobar solution	Spray 2-3 times in 10 days interval for the control of bacterial and fungal diseases.	20	66.67
RYSS mediated ZBNF practices				
9.	Growing intercrops	Growing marigold, onion, garlic are as intercrops	16	53.33
10.	Pheromone traps	Installation of pheromone traps @ 40 per acre from 30-150 DAS for the control of fruit and shoot borer.	28	93.33
11.	Releasing Trichograma	Releasing 20,000 trichograma parasitoids per acre	21	70
Bendi and its Practices followed by the farmers under ZBNF (n=30)				
Pure ZBNF practices				
1.	Seed treatment with Beejamrutha	Helps to increase the resistance capacity of seedlings for pests and diseases.	30	100
2.	Incorporation of FYM	Incorporation of 4 T/acre in last ploughing	15	50
3.	Irrigation after sowing	Immediate irrigation after sowing and the second 4-5 days after first irrigation.	22	73.33
4.	Tobacco solution	Spraying 1% tobacco solution for the control of red mites and lamp worms	14	46.67
5.	Spraying of neemasthra	For control of bendi shoot and fruit borer at initial stages	28	93.33
6.	Spraying of agniasthra	For control of bendi shoot and fruit borer at later stages	28	93.33
7.	Spraying fermented buttermilk	Spraying 6% fermented buttermilk for the control of Powdery mildew	24	80
8.	Spraying of milk solution	spraying 5% of milk solution twice in a week interval for the control of viral diseases	20	66.67
RYSS mediated ZBNF practices				
9.	Sowing boarder crops	Sowing maize as a boarder crop in 2 rows around the bendi crop.	16	53.33
Mango and its Practices followed by the farmers under ZBNF (n=26)				
Pure ZBNF practices				
1.	Ghanajeevamrutham	Application of ghanajeevamrutham @100-150 gms per plant at the time of planting	26	100
2.	Dhrava jeevamrutham	Application of dhrava jeevamrutham @ 1 lt/plant for 15-20 days intervals	26	100
3.	Panchagavya	Application of panchagavya monthly once	22	84.62
4.	Mulching	Placing straw, dry leaves, rice bran and ground nut shells at the base of the each tree.	24	92.3
5.	Spraying of asafoetida and gobar solution or neemastra or fermented buttermilk	Spray two times in 10 days interval for the control of mango hoppers.	22	84.62
6.	Spraying of verticillium	Acts as a bio pesticide for the control of mango thrips	15	57.69
RYSS mediated ZBNF practices				
8.	Optimum population	Planting 70 Mango saplings per acre	18	69.23
9.	Growing inter crops in early stages	Growing crops like papaya, turmeric, ginger and vegetables as intercrop during early stages of mango crop	20	76.92

** Multiple responses

Table 2: Distribution of pure and RYSS mediated ZBNF practices

No. of pure ZBNF Practices	**:**	**26**
No. of RYSS mediated ZBNF practices (IPM practices)	:	12
Total No. of practices	:	38
Percentage of pure ZBNF practices	:	68.42%
Percentage of RYSS mediated ZBNF practices (IPM practices)	:	31.58%

The farmers were growing Bendi, cent percent practiced seed treatment with beejamrutha followed by 93.33% applied agniasthra and neemasthra, 80% applied fermented buttermilk; 73.33% given irrigation and 66.67% farmers were applied milk solution in their bendi fields.

Majority of the farmers growing Mango shown cent percent implemented the practice of application of ghana and dhrava jeevamrutham; 92.3% practicing mulching materials like straw, dry leaves, rice bran and ground nut shells at the base of the each tree and 84.62% applied panchagavya, asafoetida and gobar solution or neemastra or fermented buttermilk.

The practices which ZBNF farmers were practicing in different crops include not only pure ZBNF practices but also IPM practices. Pure ZBNF practices in addition to IPM practices led to enhance efficacy of ZBNF crop protection practices which were popularized by RYSS through their grass root level extension workers.

From table 2, It is clear that though the investigator initiated the study on ZBNF hypothesizing no cost involvement in preparation of bio-solutions in adopting various ZBNF practices from seed to seed. The study revealed that most of the farmers following 68.42% pure ZBNF practices in above eight crops only 31.58% RYSS mediated ZBNF practices (IPM) like sticky traps, pheromone traps and alley ways etc.

From the above documentation, it was clear that the most of the ZBNF practices were applicable to more than one crop and multiple uses of kashayams and asthras for prevention and control of several pests and diseases in various crops. This documentation was similar to the findings of Niti et al. (2020) [2] and Saikat (2020) [3].

ZBNF Models

The ZBNF models adopted by farmers were presented in the table 2 and fig 1 clearly states that more than three fifth of the ZBNF farmers (65%) were adopted kitchen garden model in their back yard. Thirty five percent of the farmers did not adopt any ZBNF model. Only 20% and 10% of ZBNF farmers had seven - layered model and five - layered model respectively.

Table 3: Distribution of ZBNF farmers based on their adoption of ZBNF models (N=80)

S. No	**ZBNF Models**	**F**	**%**	**Rank**
1.	Kitchen garden Model	52	65	I
2.	Five - layered model	8	10	IV
3.	Seven - layered model	16	20	III
4.	Sun model	1	1.25	V
5.	Not adopted any ZBNF model	28	35	II

* Multiple responses

It could be inferred that from the table 2 and fig 1, majority of the ZBNF farmers adopted the kitchen garden model in their back yard for family consumption but not for commercial purpose. This consumption of vegetables from their own

kitchen garden made them feel highly satisfied and helped in gaining good health, expressed by the ZBNF farmers. ZBNF farmers also expressed that they did not market the vegetables. The seeds for kitchen garden were distributed by the government of A.P. through Community Resource Persons to the farmers at free of cost.

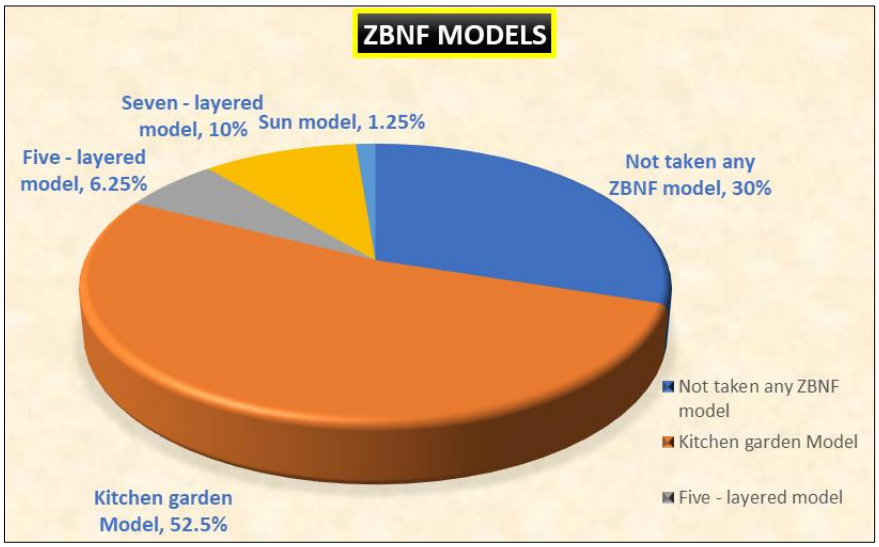

Fig 1: Distribution of ZBNF farmers based on their adoption of ZBNF models

It was also observed that very less number of farmers adopted the seven - layered and five - layered models. These models were adopted partially by the farmers with no maintenance of exact proportion of plot and number of plants. Only one farmer adopted the sun model since three years in exact proportions. He reported that this model is very economically profitable as well as ecologically sustainable.

Thirty five percent of ZBNF farmers did not adopt any ZBNF model because they had no knowledge and skills in laying of plots for ZBNF models, no training with respect to ZBNF models and no time due to their busy engagements in other farm enterprises, the extension officers giving less importance to the ZBNF models by extension of them. These findings were similar to the findings of Khadse and Rosset (2019) [1].

Cropping systems followed by the respondents

Regarding cropping systems followed by the ZBNF farmers presented in the table 3, it was clear that majority (85%) of the ZBNF farmers followed paddy, maize and pulse cropping system2 followed by paddy, maize and vegetables cropping system as expressed by 75% farmers.

Table 4: Distribution of ZBNF farmers based on cropping systems followed by them (N=80)

S. No	Cropping Systems	F	%
1.	Paddy → Maize → Fallow → Green manure	50	62.5
2.	Paddy → Maize → Pulses (GG/ BG/ HG)	68	85
3.	Paddy → Maize → Sesamum → Green manure	32	40
4.	Paddy → Maize → Sesamum	20	25
5.	Paddy → Maize → Vegetables	60	75
6.	Paddy → Sesamum → Pulses (GG/ BG/ HG)	6	7.5
7.	Paddy → Ragi → Green manure	32	40
8.	Paddy → Paddy → Pulses	12	15
9.	Cotton + Red Gram → Green manure	12	15
10.	Cotton + Red Gram → Fallow	20	25
11.	Cotton → Fallow	8	10

GG = Green gram, BG = Black gram, HG = Horse gram

* Multiple responses Vegetables = (Tomato, Chilli, Cabbage, Cucurbits, Brinjal, Bendi and leafy vegetables)

Conclusion

On the basis above findings, we can conclude that the practices followed by the most of the ZBNF farmers were pure ZBNF practices like application of ZBNF bio-solutions and also practicing IPM practices like traps, intercropping and sowing boarder crops for effective crop protection and some ZBNF farmers were practicing ZBNF practices along with organic farming practices like application of FYM and NADEP compost. However the ZBNF farmers were eliminated the usage of agro-chemicals like insecticides, pesticides and fungicides from their regular farming practices. The fact that complete dependence on pure ZBNF practices leads to relatively low yields in initial years in ZBNF comparison to Non-ZBNF farmers though quality is high. To compensate the loss with relatively low yields in initial years farmers were using RYSS mediated ZBNF especially taking plant protection measures to enhance yield and income. Farmers were inclined to use RYSS mediated Zero Budget Natural Farming namely APCNF.

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