Rice Cultivation for Food Security at Varanashi Farms, Adyanadka

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Abstract

Rice is one of the crop at Varanashi Farms a certified organic farm situated in Coastal Karnataka, India. The paper gives the information collected during last three decades on the cultivation practices, experiments conducted and its results. In this farm use of local varieties and organic farming were found beneficial. The puddling system of cultivation has been found unsustainable and uneconomical. The information on initial efforts on dry system of cultivation is also given.

Key words: Rice, organic cultivation, composting

1. Introduction

Rice is one of the most important cereal food crops in the world. In Southern India, particularly in Coastal areas, there is no meal without serving rice.

Rice is a crop of very wide physiological adaptability. More than 3,000 rice varieties are reported to exist which differ in the season of growth, period of maturity, suitability to different conditions of soil, rainfall, temperature, altitude and adaptability to such special environments as flooded land, alkalinity, salinity and acidity of soil, depth of standing water etc. Consistent with such wide adaptability, the methods of cultivation practiced differ a great deal, as well.

During the Green Revolution of past few decades, the introduction of high yielding varieties, chemical fertilizers and pesticides, flooding system of cultivation has decreased the diversity in rice cultivation. Though, these changes increased yield initially, they have brought problems, which rendered the cultivation unsustainable. The present paper discuses the trials conducted, the failures faced, successes achieved and observations made on rice during the last 23 years at Varanashi Farms, Adyanadka.

2. Description of the Project

Varanashi Farms (VF), Adyanadka is situated in the southwestern side of

Karnataka State, India and is about 25 km from Arabian Sea. The Farm growing various commercial plantation crops is certified organic by SKAL. Rice is also cultivated here for self-consumption.

2.1 Topography and climate

Adyanadka is at 120 m above MSL. The land is undulating with small hillocks. The weather data of the region are given below:

Annual rainfall - 3400 mm (mostly from June to November)
Temperature - Maximum 28 - 35^{0}C; Minimum 18 - 24^{0}C
Humidity - 60 – 90%

2.2 Situation upto 1970

In 1970s of the total cropped area at VF, major portion was under rice cultivation. The rest was occupied by arecanut with intercrops like banana and pepper. Coconut and cashewnut were the other crops grown. The salient features of rice cultivation of that time are listed below:

Ploughing was done using bullocks. The traditional varieties of rice were cultivated. Farm yard manure, green leaves, forest litters were the manure source. There was no pesticidal spray. During this period, two crops of rice were raised in a year and three crops, in some low-lying patches of the farm. Proper management of the rainwater raised the first crop whereas for the two succeeding crops, water was stored by constructing two temporary barrages built across a stream flowing in a corner of the farm diverting the same to the rice fields. After the second crop, black gram/horse gram/vegetables used to be cultivated in a few plots.

2.3 The period 1970 to 1981

During this period, power tiller began to be used replacing the bullocks. Chemical fertilizers partially replaced FYM. A few high yielding varieties (HYVs) were tried along with traditional varieties. The cropping pattern continued to be more or less the same.

2.4 The period 1981 to 1991

In 1981, the first author of this paper after his studies from a Farm College took over the management of Varanashi Farms from his father. He attempted some changes in the cultivation practices including use of HYVs with a hope of achieving higher yield. The changes/trails made and the results obtained are discussed here-under.

Introduction of high yielding varieties: In order to increase the yield, new HYVs (Table-1) were introduced at Varanashi Farms. Experimental cultivation of the North Indian scented variet; Basumathi and the very short duration variety Kalyani were also tried.

Manuring as per the package of practices: Rice fields started receiving recommended dose of manures as per the package of practices. The dosage was decided based on soil test data. Thus, 5000 kg of FYM, 100 kg N, 75 kg P_2O_5 and 87.5 kg K_2O were applied. Now and then, lime was also applied to correct the pH. Often, the organic manure quantity was reduced due to their preference of application to the plantation crops. However, chemical manure application was regular.

Table-1: Rice varieties tried at VF

Variety	Characters	Duration in days	Reported yield q/ac	Reported yield q/h	Straw yield q/ac	Straw yield q/h
A. Traditional varieties						
Kayamme	LB	115		47.9	18.23	45.57
Rajakayamme	SB	180		28.0	19.6	49.00
Gandhasale	LS	175	14.64	36.6	33.25	83.12
Massuri	LS	175	15.13	37.8	18.39	45.97
B. High yielding/introduced varieties						
Jaya	LB	140 - 145	32.5	81.25		
Phalguna	LS	135 - 145	26.5	66.25		
Jyothi	LB	120 – 125				
Kalyani-1	LB	70 (74)				
Basumathi	LS	125				
Shakthi	LS	105 – 110				
Kaveri	LB	105 - 110				
Rathna	LS	105 - 110				
Intan	LS	160 - 170	20.5	51.25		
Annapoorna	SB, RK	105 - 110	22.5	56.25		
Pusa	LS					
Hybrid IAHS 200 – 015	MB	130 - 135	36.0	90.00		
Ygai						
Athikaya						
BT Bhatta						

SB – Short Bold; LB – Long Bold; LS – Long Slender; MB – Medium bold; RK – Red Kernelled.

Reported yield and other information partially from: Anonymous-A (1978), Anonymous-B (2003).

Wet nursery to control weed growth: During earlier days soon after the previous year's crop, the land used to get one round of ploughing. Then on receiving pre-monsoon showers in May the land used to get ploughed and rice seeds were sown to raise dry nursery. Some weeds used to come up along with rice plants creating problem while transplanting. To overcome this problem, wet nursery method became the preferred practice. Thus rice seeds are sown only after regular arrival of monsoon rains.

Pest and diseases: Efforts to control Blast disease (caused by *Piricularia oryzae*), stem bores (*Schoenobius incertuillas*) leaf roller (*Cnaphalocrocis medinalis*) ear head bug (*leptocorisa varicornis*) are the major disease and pests causing damage to rice in this part. These were not serious during the earlier period. But, the introduction of HYVs and chemical fertilizers increased the maladies. To control them chemical pesticide use was adopted as a regular practice. Initially, one or two initial sprays used to provide control. Subsequently, seed treatment, spray in the nursery, seedling dip and two or three sprays to the standing crops were practised using even newer chemicals. Even then crop failure were regular features.

Failures and uneconomical yield – more efforts and more experiments: The coastal Karnataka soils are acidic in nature and poor in nutrients, especially phosphorus, potash and some micro-nutrients. The rice yield here is generally around 20-35 q/h in favourable years and often much lower than this. Efforts to make the rice cultivation economical and their outcome are discussed as under.

Growing green manure crop: To augment the organic manurial source and organic matter in the soil, the rice land was ploughed immediately after pre-monsoon showers and sun hemp (*Crotalaria juncea*) was sown. When this green manure leguminous crop is about 30-40 days old, it was ploughed into the soil. This was when the rice field was getting prepared for transplanting. Sun hemp is not a regularly grown green manure in the area. The seed supply has to be from the plains of Karnataka, which was a problem. Further, allowing the weeds to grow and ploughing them *in situ* was found more economical. Thus, the soil fertility is improved by these practices. Moreover, soil disturbance is reduced.

Fokuvoka method: The "One-Straw Revolution" suggested by Fukuvoka was adopted in rice in about 0.75 ac land in VF. The method mainly involves returning the straw to the land after harvest. It was noticed that there was more of weed growth suppressing the rice yield. It may be that it is not suited to our area and it may need modifications to obtain proper yield.

Crop rotation: In the double cropped area of rice, efforts were made to raise black gram crop after rice crops by adopting two methods of sowing:

(i) Sowing black gram seeds just earlier to rice harvest.
(ii) Ploughing the land after rice harvest and then sowing black gram.

Due to low fertility and pest problems, the black gram yields were not attractive. However, the former practice is continued wherever the moisture status of the soil at the time of rice harvest is favourable.

Conversion of paddy fields to perennial plantation crops: Arecanut is the major plantation crop in this area. During 1980s and 1990s, the price of arecanut has gone up steadily due to which arecanut started replacing rice, in many localities. In 1980s, Varanashi family had fairly good area under arecanut. Though they could not completely resist the conversion of rice area to areca plantation, they preferred food crops for this purpose like coconut, banana, cocoa etc. to plant in rice fields. Even teak in certain areas was planted. However, about one-third of the original rice area is still maintained so as to get good quality rice for self-consumption and fodder for cows maintained for milk production.

3. Rice cultivation-1992 onwards

It was in 1992 that the ancient practice of organic method of cultivation was re-introduced in VF. Accordingly, modifications were made in rice cultivation. These and their outcome are discussed here.

3.1 From chemical to organic farming

Till 1991, application of chemical fertilizer and pesticides was common in VF. In 1991, coir pith, an agro-industrial waste abundantly available in nearby coir factories, was introduced in VF as a source of organic material. This was composted using additives like urea and rock phosphate. *Pleurotus sajor-caju*, a mushroom fungus, was also added as an inoculum. This compost is named as Varanashi Co-compost. After some years, while compost preparation, urea was replaced by coffee husk as source of nitrogen to qualify for 100 per cent organic. The Varanashi Composter containing bio-control agents, N-fixers and P-solubilizers was added instead of *Pleurotus* to degrade and bio-enrich the compost. The cattle shed maintained for the production of milk in the farm produces FYM (Mixture of cowdung and forest leaves) to some extent. It is composted and used. In 1997, poultry manure was introduced and rock phosphate was withdrawn. Such compost was applied to the fields at the rate of 10 tonnes per ha. The nutrient content of various materials as well as the compost is given in Table-2. In recent years about 500 kg composted poultry manure is used as top dressing before the flowering of rice crop. Thus, since 1992, there is no application of chemical manures or pesticides to any crop in VF.

Table-2. Average nutrient status of various materials / compost used in VF

Material	N	P	K	O.M	Ca	Mg
Coir pith	0.4	0.08	0.8	120:1 (C:1)	0.9	0.7
Coffee husk	1.5	0.3	2.8	93.7		
Poultry manure	3.3	4.8	2.8	58.5		
Press mud	2.1	3.4	0.7	81.5	3.0	2.1
FYM						
Varanashi co-compost (with coir pith, coffee husk and poultry manure as raw materials)	2.1	1.8	1.9	21.3 (C:1) 64	4.0	0.7

3.2 The proven local varieties re-introduced

The tall long duration local varieties of rice namely Kayame, Rajakayame and Gandhasale were re-introduced in the major area. With minimum pest and disease problems, they are preferred even if the yield is less, because of the abundant straw obtained. Otherwise, rice straw is to be purchased to maintain cattle paying very high price. Today, a major portion of the rice straw for the district comes from plains of Karnataka, 250 – 300 km away. The cost is about Rs. 4.00 per kg. Compared to about Rs.5/- of non-hulled rice. Thus even at low yields rice cultivation is economically sustainable.

3.3 Early season cultivation, minimum problems

Varanashi Farm has gone back to the old practice of raising dry nursery in the fag end of summer to give healthy seedlings.

During summer, the pest and disease inoculum in soil is low causing minimum problem to the rice seedlings in the nursery. Thus, in VF rice seeds are sown in the dry bed in the fag end of summer. The incidence of pest attack on the nurseries, which are, at times, sown delayed, is considerable. The local remedy of wood ash application is practiced for this purpose. It is also observed that by this early start of nursery, there is early maturity and harvest of rice coinciding with the dry spell in October, safe-guarding the crop from the unpredictable rains. If a comparison of the cost analysis of one rice crop to double cropped nice is made, it is seen that the former is beneficial,

with black gram/green gram/cowpea/vegetables grown in place of second rice crop. This is so, because the second crop of rice is prone to pest problems. Also irrigating this crop, especially at the maturity stage becomes difficult. These ground realities have made VF adopt single cropping of rice in their farm, providing simultaneously rotation with the above said crops, wherever possible during the second crop season.

4. Madagascar Method of Cultivation

It is known that puddling the soil for rice partly washes away the top soil and nutrients year after year. Perennial crops, on the other hand, require minimum soil disturbance and so, are sustainable in this area. Under such circumstance, Madagascar system of rice cultivation, which does not need puddling, appears more attractive.

4.1 Features of Madagascar system of rice cultivation

* Dry nursery is raised using 3 – 5 kg seeds /h of land.
* The main field is prepared by two rounds of shallow dry ploughing after manure incorporation with minimum moisture.
* Mark the land by drawing parallel lines both ways at 30-cm spacing.
* Transplant 8-12 day-old (not older seedlings) one at a time at 30cm spacing. The seedlings should be transplanted within 10-15 minutes after pulling from the nursery bed.
* Instead of transplanting the seedlings, direct sowing at the rate of not more than two seeds per hill is also possible.
* Give light irrigations to keep the land moist.
* Weeding is the most important part for the success of the system. When the plant is young, one or two rounds of manual weeding are to be done. Subsequent weeding could be done by means of an inter-cultivator. For this, planting seed/seedling along the lines in both directions is very important.
* Madagascar method of cultivation encourages tillering and hence gives higher yield with less water and seed expense. There is no puddling hence, no washing of the soil and nutrients takes place.

4.2 Attempts to adopt Madagascar Method at Varanashi

In June 2003, an effort was made in VF to cultivate rice by Madagascar method by direct seed sowing method. The workers were instructed to sow three or four seeds (instead of two, as understood later). But often, more than six seeds went to the field. The spacing was also quite close. Because of the competition, the plants became too weak. Further, we are used to minimum or no weeding in the wet cultivation method, only two rounds of weeding was done. All these ultimately resulted in poor yield.

The method was tried again during the second crop season in the same year using Jyothi, a dwarf rice variety. At this time, two treatments were taken up. They are

(i) regular-flooding method of cultivation but seeds were sown instead of transplanting the seedlings; and (ii) seeds sown in field with two rounds of dry ploughing.

Even in the second attempt, instead of two seeds, more number of seeds got sown (the workers could not believe that two seeds are sufficient). Hence, thinning had to be done after germination leaving 2-3 plants per hill. Initially, the system was showing better stand. However, the yield was only one-third that of conventional method. It appears that weeds were responsible for the low yield. Four rounds of hand weeding were done against required eight rounds (!). After detailed discussion with Mr. Narayana Reddy, a progressive farmer who has successfully adopted this method, another round of trial is underway in 2004 season.

5. Yield over a period of time

Upto 1988, about four hectares of land was under rice cultivation in VF. Slowly, the area has diminished giving way to other perennial crops. The average yield obtained since 1982 is presented in Table-2 and Fig. 1. The exact yield data of the period upto 1982 could not be obtained. Since the second crop of rice was continuously giving very low yield, raising second crop of rice was abandoned from 1988-89. Though, the introduction of HYVs and chemicals marginally improved the yield in certain years (1992-93 and 1993-94), the practice also showed all time low yield(1986-87).

It is also seen from the table that the organic period has taken some time to pick up in yield and this practice is doing better at later period.

The maximum rice yield achieved in recent time is 99.6 q/ha by a award wining farmer in Karnataka (Anonymous, 2003). It is in a small patch of land. The average good yield for local varieties is around 35 q/ha (Anonymous-B, 2003) and for HYV 50-80 q/ha (Anonymous, 1978). Krishnappa et.al., (1985) has reported 47-52 q/ha yield with good chemical manure management. The average yield in India is 10.7 q/ha. Compared to countries average yield the performance in VF is quite satisfactory. In fact quite often when a only single good field is taken into account a yield around 38 q/ha has been harvested. However, much need to be done to achieve sustainable good aveage yield, which can compete with expanding plantation crops.

Table-3. Average rice yield at Saravu block of Varanashi Farms

Year	I crop Q/ha	II crop Q/ha
1982-83	16.13	13.0
1983-84	24.38	9.05
1984-85	21.17	14.43
1985-86	19.63	7.40

1986-87	11.83	7.65
1987-88	22.03	9.28
1988-89	20.60	N.C.
1989-90	18.82	N.C.
1990-91	22.13	
1991-92	23.35	
1992-93	14.83	
1993-94	15.15	
1994-95	17.28	
1995-96		
1996-97		
1997-98		
1998-99	16.08	
1999-2000		
2000-2001	19.30	
2001-2002	16.55	
2002-2003	25.78	
2003-2004	25.13	

Note: Rice area (1) upto 1987-88 (2^{nd} crop) - 4 ha
(2) 1987-88 to 1994-95 - 2.9 ha
(3) 1995-96 to 2001-2002 - 1.9 ha
(4) 2001-02 to 2003-2004 - 2.7 ha

6. Soil nutrient status

At VF, soil testing is practised since 1975. Since 1995 the tests are more often done. Table-3 presents the data on soil nutrient status of three rice plots. Among these, Kolake gadde is situated in the low area getting submerged once in a way during the rainy season. Based on soil test value modifications in the manurial practice including liming has been carried out during the chemical period. The soil pH of all the 3 plots remained acidic through out the period but used to improve wherever liming was done. The organic carbon content, an index of nitrogen was higher at the early period i.e. before the introduction of chemicals than in the chemical period. However, the ingredient improved later on with reintroduction of organic cultivation.

The fluctuation in available phosphorus is also similar. From the nearly the satisfactory status during the earlier period, it got drastically reduced during chemical period. At time rock phosphate was the source of this nutrient. In 1997 onwards, rock phosphate was replaced by poultry manure, which is also rich in nitrogen and potash. The change over to poultry manure has resulted in improving the phosphorus status in two plots.

Available potash level in the rice soil has shown linear response with the application of this nutrient either through the potassic fertilizer during the chemical period or through the potash rich coffee husk during the organic period.

Table-4. Soil nutrient status of rice fields of VF

Nutrient component	Kolake Gadde						
	Testing (month / year)						
	5/95	4/91	3/95	5/97	6/98	5/01	5/04
PH	4.9	5.4	5.4	4.7	NA	4.7	5.1
Org.carbon (%)	71.26	71.26	2.0	1.95	NA	2.3	1.9
P_2O_5 (kg/ac)	16.0	73.2	11.0	Tr.	Tr.	Tr.	Tr.
K_2O (kg/ac)	20.0	36.0	55.0	13.3	109	80.8	110.3

Nutrient component	Huli Adi						
	Testing (month / year)						
	5/95	4/91	3/95	5/97	6/98	5/01	5/04
PH	5.1	NA	5.1	4.7	NA	5.0	5.0
Org.carbon (%)	71.26	NA	1.3	1.12	NA	1.7	1.5
P_2O_5 (kg/ac)	16.8	NA	31.5	Tr.	14.3	Tr.	26.5
K_2O (kg/ac)	26.0	NA	60.5	63.0	46.0	63.4	106.0

Nutrient component	Mantame						
	Testing (month / year)						
	5/95	4/91	3/95	5/97	6/98	5/01	5/04

PH	5.2	5.7	5.7	4.8	NA	5.1	5.4
Org.carbon (%)	71.26	71.26	0.8	1.5	NA	1.0	1.0
P_2O_5 (kg/ac)	29.2	10.18	25.8	14.4	14.3	13.8	28.75
K_2O (kg/ac)	28.0	16.0	60.5	53.0	46.0	91.8	137.7

Note: NA - Not analysed; Tr. - Traces

Table-4 presents the soil nutrient status of a field wherein Madagaskar method of cultivation is underway. (To compare the data, the latest available report of the same field is also given). The results bring out some interesting information. The Madagaskar system showed improvement in pH from 5.0 to 5.4 and also available potash from 106 to 153 kg/ac, while there is no perceptible change in the phosphorus status. It may be too early to mention that the results shows the potentiality of the system.

Table-5. Soil nutrient status of Madagaskar paddy field in comparison to conventional rice field

Field particular	pH		O.C. %		Available P_2O_5 kg/ac		Available K_2O kg/ac	
Test date	5/2001	5/2004	5/2001	5/2004	5/2001	5/2004	5/2001	5/2004
Conventional field	5.0	5.0	1.7	1.5	Tr.	26.5	63.4	106.0
Madagaskar field	5.0	5.4	1.7	1.5	Tr.	28.75	63.4	133.3

7. Changes in water source and irrigation method

It is well known that monsoon breaks in the first week of June in the coastal Karnataka. Within a few days, the monsoon picks up and by the end of the month the rivers and streams are the streams and by June 30th their brim with abundant water. Thus, the first crop of rice does not require any special arrangement for irrigation. However, at times, unusual dry spell can prevail during the mid monsoon season which causes water stress for the crop. A few decades earlier, this problem was overcome by building temporary blocks/bunds locally called Kattas, across the stream fields and transporting the water in long channels to flow to the rice fields. With introduction of the pump-sets pumping the water was found to be easier dispensing the katta irrigation in course of time, when there is a drastic reduction in the second cropped area. With the switchover from rice to plantation crops like arecanut, the number of kattas fell drastically. For instance, the Moodambail-Saravu stream of about 6 km length flowing

on the western side of the Varanashi Farms and joining Seere river (flowing in Southern side), used to have many temporary kattas during the rice cultivation season earlier. But now due to the aforesaid reasons, there are fewer kattas.

All these have caused considerable reduction in water percolation resulting in lowering water table. Further, the increase in arecanut cultivation, which needs 2.5 cm of irrigation every week during the summer, has created water scarcity during summer in this heavy rainfall region!

In 1983 summer, the water scarcity was acute as the pre-monsoon showers failed together with the late arrival of regular monsoon. Many arecanut gardens dried up during the year. The pinch was also felt in VF. In order to overcome such crisis thereafter. VF started adopting different types of the water harvesting techniques. These efforts have paid rich dividends. For example, though the water shortage is severe in all the surrounding area during 2002 and 2003, VF had no problem. VF along with Varanashi Research Foundation is also trying to revive the Katta building tradition by developing a new method using plastic sheet and sand bags named Varanashi Plastic barrage instead of stone and soil. The information on water harvesting and Varanashi Plastic barrage has spread and farmers all around are adopting the same. The neighboring farmers in the Moodambail-Saravu stream have revived a good number of old Kattas. During 2003, it is of interest to note that four Varanashi Plastic barrages were constructed in the Seere River benefiting the farmers nearby.

8. Growing forest

Upto 1990, green leaves of the forest trees growing within the VF land and surrounding village common land were the only source of organic manure for rice as well as other plantation crops. In 1991, coir pith an agro-industrial by-product was brought in. Subsequent years saw introduction of more such materials such as cocoa pod waste, coffee husk, poultry manure and press-mud. These materials in addition to giving organic matter are also rich in plant nutrients (Table-2). Development and adoption of VRF Method of Composting(Moorthy *et.al* 1997) also increased the efficiency in nutrient management. Off late effort is underway to effectively utilize the human waste. At present, septic tanks connected to Farm workers quarters are feeding digested slurry to the plantation. Thus, the need to cut the tree branches for the sake of organic farming does not arise. So today 30 per cent of the total land at VF is with all types of plant growth either natural or introduced. These trees also harbor birds and other natural enemies, which play major role in the natural pest control in the rice crop and other plantation crops of VF.

9. Conclusion

The following conclusions/observations are drawn, based on farm experience and trials:

1. Local varieties are more pest and disease resistant; can give sustainable yield; require less input; and hence, more profitable.

2. Rice cultivation need to be initiated during May, once the pre-monsoon showers are received.
3. Raising early dry nursery is to be encouraged as it will be less prone to pests and diseases.
4. In this high rainfall area, only one long duration rice crop and subsequently leaving the land fallow appears to be more economical.
5. The average rice yield in this area is low. So, it is very difficult to resist the temptation of converting the rice field to other plantation crops.
6. Because of high rainfall, the puddling system of rice cultivation, which results in the washing of valuable top soil and plant nutrients, is not ecologically sustainable. There appears to be some scope for non-puddling system of rice cultivation like Madagaskar system with suitable modifications.
7. Systematic recycling of farm waste, agro-industrial wastes and human waste will have the way for successful organic farming. VRF method of composting is one of the ideal ways to recycle.
8. Water harvesting, building temporary Kattas at the end of monsoon season are the methods to be adopted to augment the irrigation water.

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