Impact Assessment of APCNF

(Andhra Pradesh Community Managed Natural Farming):Kharif-2019-20 Report

Institute for Development Studies, AP
Prof. Quarters 7 & 8, Engineering College Campus
Andhra University, Visakhapatnam 530003
Phone:+91-863-2346536; Email: info@idsap.org;
Website: http://www.idsap.org

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Acronyms

AHH	:	Agriculture Household
AP	:	Andhra Pradesh
APCNF	:	Andhra Pradesh Community Managed Natural Farming
ATMA	:	Agriculture Technology Management Agency
AWC	:	Anganwadi Centre
CA	:	Cluster Assistant
CCE	:	Crop Cutting Experiment
CESS	:	Centre for Economic and Social Studies
CRP	:	Community Resource Person
CS	:	Case Study
CSPro	:	Census and Survey Processing System
DES	:	Directorate of Economics and Statistics
DPM	:	District Project Manager
DWAMA	:	District Water Management Authority
FDG	:	Focussed Group Discussion
FPO	:	Farmer Producers Organization
GCA	:	Gross cropped area
GCC	:	Girijan Co-operative Corporation
HH		Household
IASRI	:	Indian Agricultural Statistical Research Institute
ICRP	:	Internal Community Resource Person
ICT	:	Information and Communication Technology
MGNREGS	:	Mahatma Gandhi National Rural Employment Guarantee Scheme
NAPCNF	:	Non-Andhra Pradesh Community Managed Natural Farming
NGO	:	Non-Government Organization
NPN	:	Non-Pesticide Management
NSSO	:	National Sample Survey Organization
PDS	:	Public Distribution System
PNPIs	:	Plant Nutrients and Protection Inputs
RySS	:	Rythu Sadhikara Samstha
S2S	:	Seed to Seed

SDES : State Directorate of Economics and Statistics

SHG : Self Help Group

SI : Strategic Interview

Executive Summary

The study

The objectives of the study are:

1. To observe and measure the changes in expenditure on plant nutrients and protection inputs (PNP), and the total cost of cultivation and net returns from crop cultivation, due to Andhra Pradesh community natural farming (APCNF) projects;
2. To assess the impact of these changes on farm families and the production at the state level
3. To estimate scientifically the changes in the crop yields due to APCNF.
4. To capture the perceptions of the realized and potential benefits of the APCNF in enhancing the crop yields, farm incomes, employment creation at the project level and at the state level.
5. To assess the impact of the APCNF on soil quality and crop output quality
6.
7. To understand the farmer's perceptions about APCNF, in terms of environmental and wellbeing, and
8. To provide insights for mid-course corrections/ improvement and recommendations for policy changes.

The evaluation methodology adopted was what is known as "**with and without**" approach;. wherein the outcomes of a random sample of APCNF farmers cultivating a set of selected crops are compared with the outcomes of a random sample of farmers cultivating the same set of crop using chemical inputs.

The study has been conducted in the late Kharif and early rabi season of 2019-20. The study has focussed on 13 major crops cultivated across the state, during the study period. Household data was collected from 1,422 APCNF farmers, covering 105 villages and 73 mandals from all 13 districts. Similarly, data was collected from 628 non-APCNF farmers, covering 63 villages of 54 mandals from all 13 districts in the state. Qualitative data was

collected through focus group discussions (FGDs), strategic interviews (SIs) with the district project managers (DPMs) and case studies (CSs).

Crop cutting experiments (CCEs) were conducted scientifically to get independent and accurate estimates of crop yields under APCNF and Non-APCNF; and the difference between them. A total of 1,762 CCEs were conducted, including 1,231plots of APCNF crops and 531 plots of control crops.

As the data collection started late, the study has collected data and conducted CCEs for late Kharif sown crops and early Rabi sown crops also. Hence the yield rates are not strictly comparable to typical Kharif yields for some crops. However, these changes do not affect the main objective of the study; i.e. comparison of crop yields, cost of cultivation and returns under APCNF and non-APCNF condition, at any point of time. The sample size for some crops was small. The result at state level and crop level are most reliable. The estimates at sub-state level (e.g. district level) and sub-crop level (e.g. irrigation and un-irrigated) are less reliable for some crops due to small sample size.

Profile of sample farmers

The profile of the sample farmers clearly indicates that RySS has been focusing on the poor and vulnerable sections. The inclusion of SC, ST, women farmers and landless/ leased-in farmers have been higher among APCNF sample vis-à-vis the control sample. Higher incidence of literates and educated farmers, youth and professionals were present among the project-APCNF sample, indicating that APCNF is gaining popularity among the educated or informed farmers, youth and professionals. Contrary to the popular perceptions and deliberately propagated assertions that natural farming is a hobby of the rich, the presence of small and marginal farmers, including leased-in farmers and the allocation of larger proportion of their holdings to APCNF vis-à-vis medium and large farmers, indicates the pro-poor nature of the project. The southern districts, especially Rayalaseema districts , have allocated larger portion of their operational holdings to APCNF. APCNF, is gaining acceptance in the southern parts of the state as a low cost cultivation model, where farmers usually adopt risk averse or low investment agriculture strategies.

Impact of biological inputs on farming conditions

The biological inputs under APCNF and chemical inputs under non-APCNF are, together, referred in this report as plant nutrients and protection inputs (PNPIs). The impact of the

biological inputs on major farming conditions, are summarised at Table 0.1. In absolute terms, by adopting biological inputs, the farmers have saved ₹986 per ha in Jowar to ₹83,359 in Chillies in PNPIs due to APCNF. The cost of biological inputs is less than that of chemical inputs by 12.59 per cent in Groundnut to 89.87 per cent in Chillies. Out of total 13 crops, the expenditure on PNPIs has reduced in 12 crops. It is interesting to know that even though the expenditure on PNPIs is higher, under APCNF, Ragi has recorded highest reduction in total paid out costs. Among all 13 crops, the paid-out costs are less under APCNF, in 12 crops. Only in Sugarcane, the total cost of cultivation is higher under APCNF by 12.72 per cent, due to inclusion of the Jaggery preparation and marketing costs, by some APCNF farmers. Out of 13 crops covered in the season, 10 crops have higher yields under APCNF. Out of three crops, viz. Cotton, Maize and Sugarcane, whose yields were low, under APCNF, Sugarcane has recorded higher gross and net returns. The obvious reason is better price realization, due to Jaggary making and marketing. Cotton too has recorded higher net returns under APCNF. Only Maize recorded lower yields, lower gross and net returns. A comparison of the yields of Maize during last two years indicate that the fluctuations under APCNF have been quite low, by about 15 times.

Table 0.1: Rates of changes in important farming indicators, due to APCNF

In percentages

Crop	PNPIs	Paid out costs	Crop yields	Gross returns	Net returns
Paddy	-64.86	-19.22	5.85	13.14	65.73
Groundnut	-12.59	-9.08	0.94	5.53	23.81
Cotton	-74.63	-35.97	-2.92	-3.11	165.65
Bengal gram	-62.39	-33.45	1.7	13.73	181.9
Black gram	-48.08	-20.51	23.24	25.21	67.08
Maize	-56.72	-18.47	-11.34	-10.97	-5.26
Red gram	-58.83	-33.3	6.24	19.64	361.43
Chillies	-89.87	-25.77	8.98	11.77	39.58
Jowar	-14.08	-1.89	10.41	11.28	23.51
Sugarcane	-43.26	12.72	-1.12	8.33	4.37
Ragi	18.8	-41.93	23.28	18.08	49.36
Onion	-74.4	-39.07	9.35	24.67	43.06
Turmeric	-67.72	-31.27	9.7	10.26	26.2
Max of above	18.8	12.72	23.28	25.21	361.43
Min of above	-89.87	-41.93	-11.34	-10.97	-5.26

Sources: Field Survey, 2019-20

The analysis of variations due to APCNF, under irrigation and rainfed conditions, broadly indicates that APCNF is more effective in reducing the cost of production under irrigation

conditions and increasing the yields, gross and net returns under rainfed conditions. The plausible reason could those farmers usually invest more under irrigation conditions and the scope for reduction in cost of cultivation is higher. As the farmers invest less and get low yields under rainfed conditions, the scope for increase in the yields and returns is very high under those conditions. Ragi is one good example. The district wise analysis of Paddy crop indicates that the poorer and interior districts too have reaped handsome gains due to APCNF.

More than 440 sample APCNF farmers have reported their experience in the model crops. The average benefit from model crops is ₹5,422 per farmer. As these interventions were initiated recently, many trees are too young to yield the expected benefits. In the coming years the economic and environmental benefits from some these models will increase manifolds.

Wellbeing and environmental outcomes

Overwhelming percentages of farmers reported several economic, health and environmental benefits due to APCNF; such as increase in soil quality, increase crop resilience to weather anomalies, perceptions about farming, reduction in family health expenditure, improvement in family financial condition, etc. (Table 0.2).

Table 0.2: District wise no of farmers reported environmental, health and economic benefits

In percentages

District	Soil quality improved	Like to continue farming	APCNF produce is tastier	Crop resilience increased	Financial condition improved	Reduction in health expenditure
Anantapuramu	100	100	96	49	66	93
Chittoor	100	100	98	34	70	100
East Godavari	99	100	93	43	97	100
Guntur	87	100	87	12	78	88
YSR Kadapa	93	99	58	41	51	74
Krishna	92	100	90	26	79	86
Kurnool	97	100	93	54	83	89
PSR Nellore	67	100	80	80	40	80
Prakasam	77	100	85	52	42	74
Srikakulam	98	99	81	84	34	94
Visakhapatnam	96	100	82	8	15	84
Vizianagaram	96	98	95	4	92	98
West Godavari	100	100	83	39	55	99
Andhra Pradesh	94	100	86		63	89

Sources: Field Survey, 2019-20

Realized and potential macro benefits

During the Kharif 2019-20, APCNF, at the project level, has prevented the use of ₹475.49 crore worth fertilisers and ₹244.85 crore worth pesticides. These savings have resulted in the larger environmental and health benefits. The project has enabled the APCNF farmers to save ₹557.49 crore in total paid out costs and realize ₹1,134.38 crore additional net returns; i.e. ₹19,558 per APCNF farmer. Had the entire crop area in the state put under APCNF, the GDP from the crop sub-sector would have increased by about 1%. When compared with normal yields achieved in the state during last five years, APCNF yields are higher by substantial margins in 12 out of 13 sample crops. The average yields of top 10 performers of APCNF indicate a huge potential to increase the crop yields. Some of the APCNF farmers, on their own, sold their produce in new market channels and realized higher prices.

In total, APCNF project has generated 54,50,364 days of additional employment for the own labour, but resulted in the net loss of 2,34,752 days of employment for the hired labour. The major reason is the nature of the preparation of biological inputs, which involves smaller tasks such as collection and gathering of inputs such as cow dung, cow urine, leaves, etc; cleaning, grading, storing of raw materials/ inputs; soaking; drying; grinding; mixing; fermenting; etc are scattered over several days have to be performed by the family members only. Thus, availability of the family labour may be a potential constraint in the expansion of APCNF in the coming years. RySS may ponder on this issue rather seriously. However, the positive feature of APCNF is that it is resulting in improved financial, health and environmental outcomes. The question to ask is "Will these improvements halt and reverse the youth migration from agriculture in the state?"

Issues, challenges and policy options

There are certain issues and challenges, which need attention of the RySS. They include fluctuations in yields of certain crops, shortage of labour and especially, family labour, marketing, preparation and use of biological inputs, etc. District wise number of farmers, who reported various issues and challenges are shown in Table 0.3. They have pointed thee major issues, viz. challenges in preparation/ procuring and application of the biological inputs, output marketing and shortage of labour, including own labour. Though the project has resulted in a marginal decline in the demand for the hired labour, the total labour absorption

went up, with worker productivity gains. In any case, there is an overall shortage of labour in agriculture. There are marked variations across the district in the percentage of farmers reporting various issues and challenges. There is less variation in the responses to those challenges, across farm categories.

Table 0.3: District wise number of farmers reporting various issues and challenges

In percentages

District	Scarcity of labour	Scarcity of family labour	Marketing	Scarcity of Desi cow	knowledge gap	Procurement of inputs	Others
Anantapuramu	24.00	8.00	23.00	26.00	3.00	12.00	4.00
Chittoor	-	-	-	100.00	-	-	-
East Godavari	4.72	12.26	37.74	17.92	6.60	17.92	2.83
Guntur	17.62	11.89	33.20	18.85	6.97	8.61	2.87
Krishna	14.64	12.86	25.36	25.00	11.43	7.86	2.86
Kurnool	7.61	3.80	15.76	40.22	5.98	22.83	3.80
Prakasam	14.29	10.60	21.66	20.28	8.76	14.75	9.68
PSR Nellore	16.58	10.88	21.76	20.73	4.66	7.77	17.62
Srikakulam	2.34	12.87	69.59	9.94	0.58	1.75	2.92
Visakhapatnam	4.08	4.08	61.22	4.08	-	26.53	-
Vizianagaram	37.50	25.00	12.50	-	-	12.50	12.50
West Godavari	3.08	2.31	47.69	45.38	0.77	-	0.77
YSR Kadapa	20.11	13.23	29.10	15.34	4.76	12.70	4.76
Andhra Pradesh	12.48	9.89	31.07	25.17	5.64	10.56	5.18

Sources: Field Survey, 2019-20

Policy options

1. Allow and facilitate the farmers to grow forest species- trees, shrubs, herbs and creepers, which give timber, high value wood, poles, medicinal products, cosmetics, spices, wild fruits, wild vegetable, etc. ***These species need very little human and family labour*** and give a steady flow of products, services and income perpetually. Introduction of forest species in the farmers' fields need the abolition of the Forest Deportment's monopoly on, and, need for permissions for, rising, harvesting and marketing of all the forest species. The Government may provide the carbon credits or cash payments for carbon sequestration services to the farmers who grow the trees on their fields.
2. Introduce the system of rice intensification, (SRI), as one of the supplementary measures under canal irrigated areas and flood irrigation crops and conditions.
3. Facilitate the production and supply of biological inputs on commercial basis to reduce the need for family labour.

4. Another option is to facilitate and encourage the formation of farmers groups and to share their labour, just like SHG groups share their savings.
5. The tree-based farming, if promoted, will improve soil quality and micro environment naturally and reduce the need for frequent application of the biological inputs.
6. RySS may facilitate the procurement of APCNF products for the Public Distribution System (PDS), School Mid-day Meals, Anganwadi centres, etc.
7. Special arrangements/ agreements and certification may be facilitated between APCNF farmers and big malls and online markets to sell organic food. This naturally requires organization of APCNF farmers into associations/ organizations. The SHG institutions may also be roped in for simple agri-products/ food processing, such as cleaning, grading, grinding, deseeding, shelling, packing, etc.
8. As and when the medicinal plants and cosmetic related plants are introduced in the farming systems, simultaneously, their processing and marketing interventions have to be initiated.
9. There is a crucial need for a complete integration or a close coordination of all departments dealing with natural resources such as agriculture, rural developments, animal husbandry, forestry, civil supplies, etc. Such integration enables the RySS/ field staff to share their resources and responsibilities for the productive/ fruitful engagement with the farmers and for the rapid expansion of the program/ project.

Chapter 1: Context, Objectives and Methodology

1.1. Context

Agriculture in Andhra Pradesh, and also in whole of India, has been in crises. Farmers have been distressed, which has been manifested in the relentless suicides of the farmers. Over three lakh farmers have committed suicides in the country since mid-1990s. About 40,000 farmers have committed suicides in the combined Andhra Pradesh (AP) alone; between 1995 and 2014. Further, about 1,000 farmers and agriculture labours have committed suicides; since 2014; in the reorganized state of Andhra Pradesh. Understanding the significance of agriculture sector in the overall economic development, both the Government of Andhra Pradesh and Government of India have been providing enormous trust for the development of the agriculture and welfare of the farmers since beginning of the planning process. The successive governments at the Centre and State have been investing heavily on the agriculture infrastructure and spending thousands of crore rupees in the farm of agriculture input subsidies, farm incentives and farmers' welfare schemes. The welfare schemes include free/ subsidized power, irrigation subsidy, fertilizer subsidies, price support, loan waivers; cash transfers such as Prime Minister Kisan Samman by the Government of India, Rythu Bharosa in AP. farmers' support programs provide some relief to the agriculture sector and farming community without addressing the root cause of the fundamental problems faced by the farm sector.

In this context, the Andhra Pradesh Community Managed Natural Farming (officially abbreviated as APCNF), which was launched in 2016 in AP, is a paradigm shift in agricultural development in the state and also in the country. For the first time in the country, a (state) Government has acknowledged and admitted the pitfalls of seed-water-fertilizer models namely the - of 'Green Revolution' and proposed to replace it with community managed natural farming .

1.2. The Conceptual Framework of APCNF

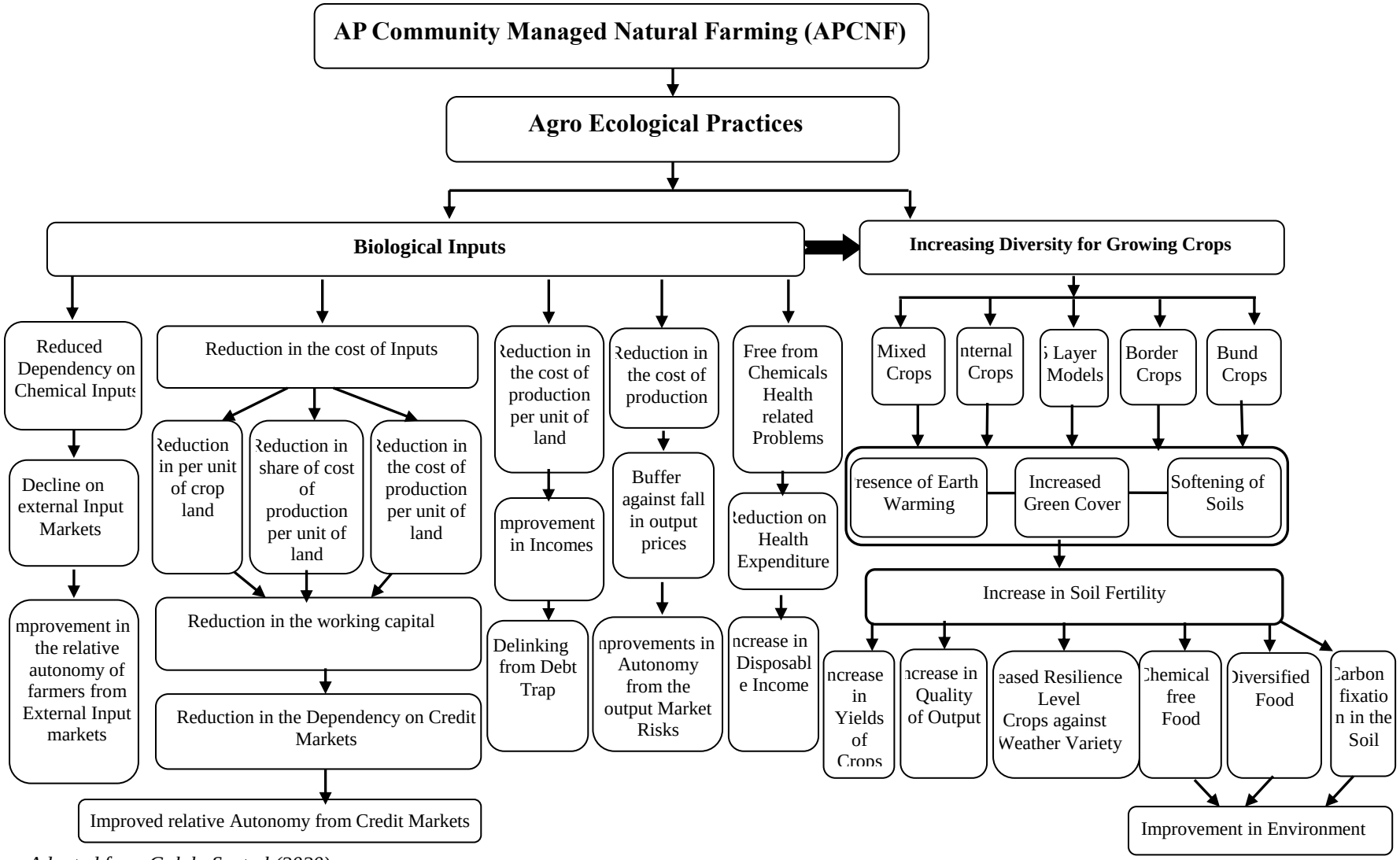
APCNF is an agri-ecological farming approach. APCNF believes that the soil already has all the nutrients necessary for plant growth. There is no need for adding any external inputs to supply nutrients. Instead, the existing nutrients have to be released and made available for the plants. APCNF facilitates this process. Beejamrutham (treating of seeds with microbial), Jeevamrutham (incorporation of microorganism into soils), Acchadana (mulching), and

Waaphasa (aeration) are the four core APCNF farming practices. In order to protect crops from pests and insects, APCNF prescribes a number of natural fungicides and pesticides, known as Kashayams and Asthrams, made from locally available ingredients like neem leaves, Chillies, garlic, tobacco, sour buttermilk, etc.

Diversification of cropping pattern is another key feature of APCNF. Under APCNF, different crops are intensively grown in a variety of ways. These include crop rotation, mixed cropping, internal cropping, border cropping and bund cropping, pre-monsoon dry sowing (PMDS) cropping, etc. One of the great innovations under this intervention is the introduction of multitier cropping models, known as 5-layer model and 7-layer model. Under these models, different varieties of fruit trees, vegetables and seasonal crops are grown on the same plot. These models have several advantages. They optimize the horizontal, vertical and temporal use of the land. Different layers of crops access the soil moisture and nutrients at different times and from different layers in the soil. The need for human labour is staggered; and it optimizes the family labour use. Farmers get higher and stable net incomes, throughout the year.

APCNF is expected to yield benefits, in two streams., viz. economic and ecological benefits. The economic benefits include reduction in cost of cultivation, increase in net returns from cultivation, reduction in input and credit market dependencies, and output fluctuations/ slumps. The environmental benefits include improvement in the soil quality, enhancement of environmental services. Food quality, improves as food is free from poisonous chemical residuals. The APCNF model, with different streams of benefit flows, is depicted in the Figure 1.1.

Figure 1.1: Conceptual Framework for Assessing the Impact of Zero Budget Natural Farming on Farming and Farming community



Source: Adapted from Galab, S, et al (2020)

1.3. Rythu Sadhikara Samstha (RySS)

To implement the APCNF across the state, the Government of Andhra Pradesh has established an independent organization known as Rythu Sadhikara Samstha (RySS), registered as section 8 company. The programme is getting widespread acceptance from the farming community. The number of participants-farmers and area under APCNF has been growing.There are 17,491 APCNF farmers spread over 1,000 villages across all the 13 districts of the state as per the 2017-18 data of RySS. They are growing 72 different crops. During Kharif 2019-20, about 5.8 lakh farmers have registered with RySS to practice APCNF across the state. The RySS target is to cover all the farmers and entire cropped area in the state under APCNF.

To validate the impact of the APCNF on the farming and farming community in the state, through an independent agency, and to get policy inputs, RySS has assigned this study to Institute for Development Studies Andhra Pradesh (IDSAP).

1.4. The Study

The main objective of the APCNF is to make agriculture economically viable, agrarian livelihoods profitable and climate-resilient. APCNF aims at reduction cost of cultivation, enhance yields, increase incomes, reduce risks, and protect the farming and farmers from uncertainties of climate change by promoting the adoption of an agro-ecology framework. It is expected that APCNF would result in substantial reduction in the expenditure on plant nutrients and protection (PNP), due to replacement of the very expensive and harmful chemical inputs with the inexpensive and benevolent biological inputs. The reduction in PNP expenditure, in turn, is expected to reduce the total cost of cultivation; and result in the higher net returns from crop cultivation. APCNF is also expected to improve the quality of natural resources, especially the soil quality, and the quality of the environmental services. The mandate of the present study is to asses, the impact, and to provide the insights for mid-course corrections, and to provide facts and figure for the advocacy.

1.4.1. Objectives of the study

9. To measure the changes in expenditure on PNP, total cost of cultivation and net returns from crop cultivation, due to APCNF; and impact of these changes.
10. To estimate scientifically the changes in the crop yields due to APCNF.
11. To learn the impact of the APCNF on soil quality
12. To know the qualitative changes in the crop output due to APCNF
13. To understand the farmer's perceptions about APCNF, in terms of environmental and health benefits, and
14. To provide insights for mid-course corrections/ improvement and recommendations for policy changes.

1.4.2.Methodology

The evaluation methodology is based on what is known as "**with and without**" approach wherein the outcomes of a random sample of APCNF farmers cultivating a particular crop are compared with the outcomes of a random sample of farmers cultivating the same crop using chemical inputs.

The study has been conducted in the Kharif season of 2019-20, including late sown Kharif crops and early sown Rabi crops during the year. The field data was collected between 19th November 2019 and 29thFebruary 2020. Over 70 crops are being cultivated under APCNF in the state. However, most of these crops are horticulture and floriculture crops, covering smaller areas. The study has focussed on 13 major crops cultivated across the state, during the study period. The crops include: (1) Paddy, (2) Maize, (3) Bengal gram, (4) Groundnut, (5) Cotton, (6) Jowar, (7) Chillies, (8) Black gram, (9) Ragi, (10) Red gram, (11) Sugarcane, (12) Onion and (13) Turmeric.

The study has planned to collect the quantitative as well as qualitative data to assess the impact of APCNF on farming community.

It is planned to select a sample of 10 villages, per district, randomly from the identified universe of the villages. The universe of villages, are all those project villages, having at least 10 APCNF farmers and cultivating at least one of the identified sample crops. Total 130 project villages were selected. From these 130 sample project villages, it is proposed to cover 1,430 APCNF farmers; including 1,040 cross section sample, 260 panel sample and 130 best farmers. Further, 65 non-project/ control villages, at the rate of five villages per district, were selected. These villages are close to sample project villages, but not affected by the APCNF interventions and practices in the neighbourhood. From these 65

control villages, total 650 control farmers were selected. A listing survey of all the households in the sample villages has been conducted to generate the universe of APCNF farmers and Non-APCNF farmers to draw the sample. It is planned to collect the data uniformly from all 13 district in state. But, as per the advice of RySS and progress of the implementation of APCNF project across the state and need to collect the minimum representative sample from all agri-climatic zones, sample collection across the districts were adjusted. More focus is given to Kurnool, Visakhapatnam and other north-costal districts. Sample size is reduced in PSR Nellore, Prakasam and Chittoor districts. Household data is collected from 1,422 APCNF farmers, covering 105 villages and 73 mandals from all 13 districts. Similarly, data is collected from 628 non-APCNF farmers, covering 63 villages of 54 mandals from all 13 districts in the state. All the data collected from the control sample farmers were used for cross section analyses. Similarly, all the APCNF data including the panel and best farmers' data has been used in this report.[1]

It was planned to collect the qualitative information through three methods, viz. focus group discussions (FGDs), strategic interviews (SIs) with the district project managers (DPMs) and case studies (CSs). In total, it was planned to conduct 104 FDGs, including 39 for the control sample groups, 130 CSs and 13 SIs. Due to late start of the survey and Covid 19 related lockdown and travel restrictions, lesser number of FDGs, SIs and CSs were completed. The sample frame is shown at Table 1.1.

Table 1.1: Sample frame work of the study

Type of sample	**Sample Unit**	**KHARIF**			
		APCNF		**Non APCNF**	
		No. of villages	**Sample Size**	**No. of villages**	**Sample Size**
Cross Section Sample	Per District	8	80	5	50
	State Total	**104**	**1,040**	**65**	**650**
Panel Study Sample	Per District	2	20	0	0
	State Total	**26**	**260**	**0**	**0**
Best Farmers Sample	Per District	0	10	0	0
	State Total	**0**	**130**	**0**	**0**
Quantitative Sample	Total		**1,430**		**650**
Qualitative Studies	Total case studies		**130**		0
	Total Strategic interviews		**13**		0
	Total FGDs in the State		**65**		**39**

Sources: IDS, 2019: Project Inception Report

Crop cutting experiments were conducted scientifically to get independent and correct estimates of yields of crops under APCNF and Non-APCNF; and the difference between

[1] The panel and bets farmers' data is also being used internally by RySS and other reports of IDS.

them. For each of the selected farmer, a plot of the land of farmer, where the farmer is growing the major crop, is identified. From this parcel of land, a plot of *size as required by the procedure* has been selected at random for estimating yield through crop cutting experiments (CCEs). It is to be noted that the study has adopted standard methodology of Indian Agricultural Statistical Research Institute (IASRI), which is followed by NSSO and Directorate of Economics and Statistics (DES) of Andhra Pradesh for conducting CCEs.It is planned to conduct at least one CCE with each sample farmer. However, due to late start of survey, CCEs could not be completed as per the plan. Total 1,762 CCEs were conducted; including 1,231APCNF crops and 531 control crops. In the report, unless stated otherwise, the yields obtained through CCEs were used in all tables and calculations such as gross and net returns.

1.4.3.Data Collection and the Management Process

Total seven research tools, viz. (1) Household listing schedules, (2) Village listing schedule (3) Questionnaire for APCNF HHs, (4) Questionnaire for Non-APCNF HHs, (5) Checklist for FDGs, (6) Checklist for Case Studies, and (7) Checklist for Strategic Interviews, were prepared. These instruments for all field-based evaluations have in-built checks with appropriate skip patterns over and above the supportive manual with instructions and clarification for all questionnaires. The research tools were finalized through a series of brainstorming consultations.

An intensive training and field testing were carried out, to train the field investigators and supervisors during November 11 to 15 at the Nagarjuna University, Guntur. The actual field survey commenced on 19thNovember 2019and continued up to the end of February 2020. Senior core team members visited the field regularly and supported the field team.

A separate mobile-based app was developed/ generated to enter the CCEs' information; and training was given to all the supervisors, after duly installing the app in their mobiles. Senior team members visited the field and cross-checked the information filled. The data entry programme was written in CSPro software and used for data entry and processing.

1.4.4.Limitations of the data

As the data collection started late, the study collected data and conducted CCEs for late Kharif sown crops and early Rabi sown crops. Hence the yield rates are not strictly comparable to typical Kharif yields for some crops. However, such adjustment in the seasons' period does not affect the main objective of the study; i.e. comparison of crop yields, cost of cultivation and returns under APCNF and non-APCNF condition. The sample size for some crops is small. The result at state level and crop level are most reliable. The estimates at sub-state level (e.g. district level) and sub-crop level (e.g. irrigation and un-irrigated) are less reliable for some crops. Hence, analysis was limited to a few crops.

1.5. Structure of the Report

The context, objectives and methodology of the study have been presented in Chapter 1. Chapter 2 describes the profile of sample households. The parameters used include social composition, literacy levels, gender, land ownership, operational area, year of enrolment in APCNF, etc. Chapter 3 consists of the analyses of the impact of biological input on the production conditions of farmers. It includes changes in expenditure on PNP, total paid out costs, crop yields, gross and net returns. The environmental and health benefits of the APCNF are presented in Chapter 4. The potential benefits APCNF, such as best farmers yields, macro estimates, expected changes over time in yields and farm returns, employment generation, emerging marketing channels, etc. have been analyzed in chapter 5. Chapter 6 discusses the issues and challenges and gives policy suggestions.

Chapter 2: Adaptation of APCNF by Farmers: some Correlates

2.1. Introduction

In this chapter the profile of sample project households and controlled households are discussed. The parameters considered in this chapter include – social categories, land ownership categories, operational holding size, literacy levels, gender categories, years of involvement in APCNF, extent of area put under APCNF, etc.District wise analysis is also carried in these parameters.1,422 project participants and 628 control participants constitute the sample used in this report. In total 1,712 APCNF and 865 non-APCNF samples of 15 crops were collected. In 1,701 APCNF and 853 non-APCNF crop data of 13 crops were used in this report.

The major objectives of this chapter are:

1. To know the spread of the APCNF among different categories of farmers.
2. To understand the effectiveness of APCNF strategy on the poor and vulnerable sections

2.2. Social Composition

Out of total 1,422 APCNF sample farmers, 180 (12.66 per cent) are Scheduled Castes (SC), 235 (16.53 per cent) are Scheduled Tribes (ST), 636 (44.73 per cent) are Backward Communities (BC) and 371 (26.09 per cent) are Open/ Other Categories (OC). Out of total 628 non-APCNF sample, 50 (7.96 per cent) are SC, 87 (13.85 per cent) are ST, 310 (49.36 per cent) are BC and 181 (28.82 per cent) are OC (Table 2.1). ***Higher proportion of SC and ST in APCNF sample vis-à-vis that of non-APCNF sample indicates the positive bias of the project towards the poor and vulnerable sections.*** In the APCNF sample, SC farmers are concentrated in Krishna and Kurnool districts; ST farmers are concentrated in north coastal districts of Visakhapatnam, Vizianagaram, Srikakulam and East Godavari. On the other hand, a greater number of BCs are found in Kurnool, Srikakulam, Vizianagaram, Visakhapatnam, Anantapuramu, and Krishna districts. The proportions of OCs are high in YSR Kadapa, Kurnool, Anantapuramu, East Godavari, West Godavari and Prakasam districts.

Table 2.1: District wise Social composition of APCNF and Non-APCNF sample households (in number& percentages)

District	APCNF					Non-APCNF				
	SC	ST	BC	OC	Total	SC	ST	BC	OC	Total
Anantapuramu	10	5	50	34	99	1	0	34	15	50
Chittoor	8	0	40	13	61	9	1	12	8	30
East Godavari	4	31	32	32	99	0	20	19	11	50
Guntur	18	10	44	28	100	14	3	17	16	50
YSR Kadapa	19	1	37	75	132	2	0	13	35	50
Krishna	42	0	49	27	118	14	0	23	13	50
Kurnool	37	8	105	59	209	8	0	67	23	98
PSR Nellore	17	5	16	8	46	1	2	7	10	20
Prakasam	14	0	14	33	61	1	1	10	18	30
Srikakulam	0	29	87	13	129	0	0	49	1	50
Visakhapatnam	0	74	57	10	141	0	20	28	2	50
Vizianagaram	3	40	84	1	128	0	20	30	0	50
West Godavari	8	32	21	38	99	0	20	1	29	50
Total	180	235	636	371	1,422	50	87	310	181	628
Percentages										
Anantapuramu	10.10	5.05	50.51	34.34	100	2.00	-	68.00	30.00	100
Chittoor	13.11	-	65.57	21.31	100	30.00	3.33	40.00	26.67	100
East Godavari	4.04	31.31	32.32	32.32	100	-	40.00	38.00	22.00	100
Guntur	18.00	10.00	44.00	28.00	100	28.00	6.00	34.00	32.00	100
YSR Kadapa	14.39	0.76	28.03	56.82	100	4.00	-	26.00	70.00	100
Krishna	35.59	-	41.53	22.88	100	28.00	-	46.00	26.00	100
Kurnool	17.70	3.83	50.24	28.23	100	8.16	-	68.37	23.47	100
PSR Nellore	36.96	10.87	34.78	17.39	100	5.00	10.00	35.00	50.00	100
Prakasam	22.95	-	22.95	54.10	100	3.33	3.33	33.33	60.00	100
Srikakulam	-	22.48	67.44	10.08	100	-	-	98.00	2.00	100
Visakhapatnam	-	52.48	40.43	7.09	100	-	40.00	56.00	4.00	100
Vizianagaram	2.34	31.25	65.63	0.78	100	-	40.00	60.00	-	100
West Godavari	8.08	32.32	21.21	38.38	100	-	40.00	2.00	58.00	100
Total	12.66	16.53	44.73	26.09	100	7.96	13.85	49.36	28.82	100

Sources: Field Survey 2019-20

2.3. Literacy levels of the sample farmers

Out of total 1,422 APCNF sample farmers, 30.82 per cent are illiterates, 23.41 per cent have primary education, 11 per cent have middle level education, 17.77 per cent have secondary education, 8.18 per cent have higher secondary, 1.34 per cent have diploma and 7.48 per cent

have education level of graduate degree or above District wise literacy levels of APCNF and Non-APCNF sample farmers are shown at Table 2.2. The table clearly shows ***that relatively more educated farmers are attracted to APCNF, which is also considered as the knowledge intensive farming***. The proportion of illiterates is significantly less among APCNF farmers visa-vis control sample. Except in primary education, the proportions of educated farmers at all levels are higher among APCNF farmers. The proportion of graduates and above educated farmers is 7.48 per cent in APCNF, compared to 4.94 per cent among the non-APCNF sample. Among the APCNF farmers, more than 11 per cent had education level of graduation and above in Vizianagaram, East Godavari, Guntur and Prakasam districts. The proportion of illiterates is very high in Srikakulam, Visakhapatnam and East Godavari; this may be due to higher presence of tribal farmers in those districts' sample.

Table 2.2: District wise and education level wise distribution of APCNF and Non-APCNF sample farmers (in percentages)

District	Illiterates	Primary	Middle	Secondary	Higher secondary	Diploma	Graduation & above	Total
	APCNF Farmers							
Ananthapuramu	22.22	11.11	20.20	30.30	6.06	2.02	8.08	100
Chittoor	15.00	56.67	16.67	5.00	3.33	-	3.33	100
East Godavari	46.46	22.22	6.06	6.06	6.06	1.01	12.12	100
Guntur	23.00	25.00	8.00	25.00	6.00	2.00	11.00	100
YSR Kadapa	21.97	25.00	6.06	22.73	12.12	3.03	9.09	100
Krishna	18.10	18.10	20.69	23.28	10.34	0.86	8.62	100
Kurnool	32.54	19.14	9.57	22.01	9.09	0.96	6.70	100
PSR Nellore	21.74	52.17	4.35	8.70	10.87	-	2.17	100
Prakasam	21.31	31.15	8.20	16.39	9.84	1.64	11.48	100
Srikakulam	54.69	17.97	4.69	11.72	6.25	-	4.69	100
Visakhapatnam	47.52	17.02	12.77	10.64	9.93	1.42	0.71	100
Vizianagaram	21.09	25.00	7.03	20.31	11.72	1.56	13.28	100
West Godavari	32.32	24.24	20.20	15.15	1.01	2.02	5.05	100
AP	30.82	23.41	11.00	17.77	8.18	1.34	7.48	100
	Non-APCNF Farmers							
Ananthapuramu	42.00	24.00	8.00	14.00	6.00	2.00	4.00	100
Chittoor	6.90	89.66	3.45	-	-	-	-	100
East Godavari	66.00	10.00	8.00	8.00	2.00	2.00	4.00	100
Guntur	32.65	24.49	6.12	18.37	6.12	-	12.24	100
YSR Kadapa	44.00	22.00	8.00	10.00	8.00	2.00	6.00	100
Krishna	36.00	26.00	12.00	22.00	-	-	4.00	100
Kurnool	39.00	25.00	12.00	14.00	4.00	-	6.00	100
PSR Nellore	15.00	30.00	10.00	20.00	10.00	-	15.00	100
Prakasam	26.67	30.00	-	33.33	10.00	-	-	100
Srikakulam	62.00	14.00	2.00	12.00	2.00	-	8.00	100

District	Illiterates	Primary	Middle	Secondary	Higher secondary	Diploma	Graduation & above	Total
Visakhapatnam	60.00	16.00	8.00	6.00	6.00	2.00	2.00	100
Vizianagaram	46.00	18.00	12.00	12.00	8.00	-	4.00	100
West Godavari	40.00	28.00	26.00	4.00	-	2.00	-	100
AP	42.36	25.00	9.55	12.90	4.46	0.80	4.94	100

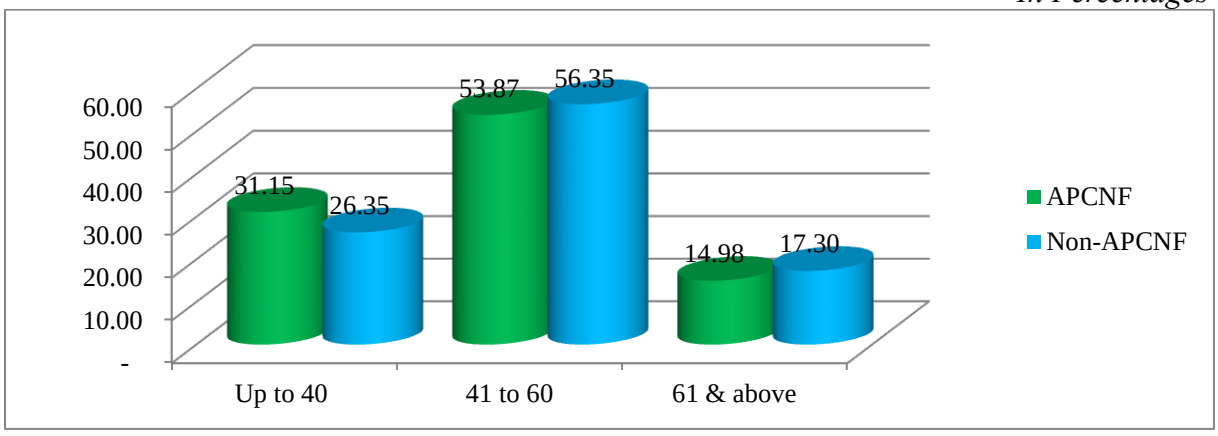
Sources: Field Survey, 2019-20

2.4. Age and primary occupations of sample farmers

It is a well-known fact that youth in India are averse towards agriculture due to low earning potentials in the sector. Even the parents are encouraging their children to move away from the agriculture. Such a trend is clearly visible in the sample. Among APCNF sample, 31.15 per cent is below the age group of 40 years; 53.87 per cent is in the age group of 41 to 60 years and 14.98 per cent is in the 61 and above age group. The distribution is even more skewed in non-APCNF sample, in which only 26.35 per cent is below the age of 40 years (Figure 2.1). One positive feature is that ***the proportion of young farmers is high in APCNF farmers by about five percentage points.***

2.1: Age-wise distribution of APCNF & non-APCNF sample farmers

In Percentages



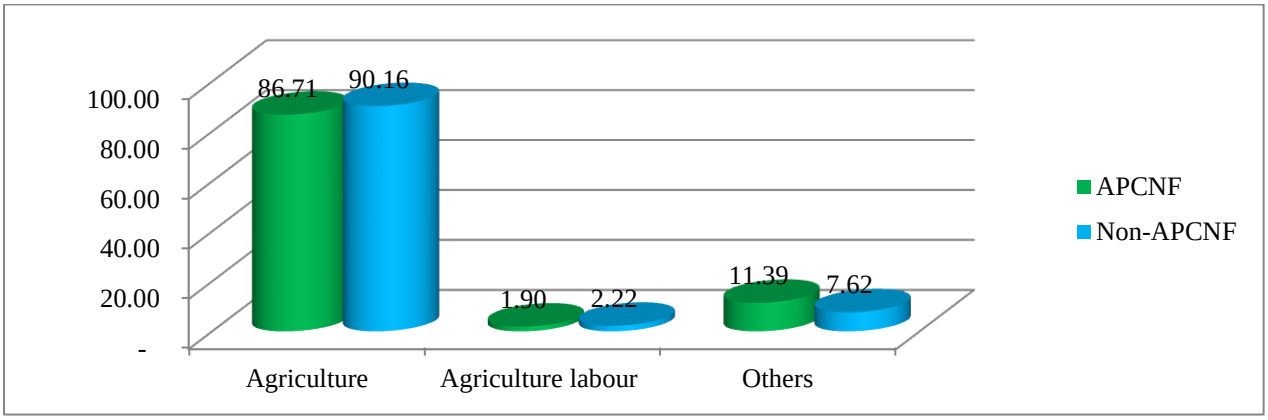
Sources: Field Survey, 2019-20

As per latest farmers' surveys by NSSO and NABARD, the farmers are deriving significant portions of their income from sources other than farming. To learn about this trend the sample farmers were asked about their primary occupation. Nearly 87 per cent APCNF sample respondents stated that farming is their primary occupation; 1.9 per cent said that agriculture labour is their primary occupation and 11.39 stated varieties of other occupations

such as salary employment, housewife/ domestic work, own business, etc. Among non-APCNF sample, 90.16 per cent are cultivators, 2.22 per centpursued agriculture labour and 7.62 per centhad others (Figure 2.2). ***It is interesting to note that relatively more number of others, which include salaried persons, professionals, self-employed, business persons, etc., are taking up agriculture under APCNF methods compared to Chemical agriculture. Possible reasons could be an urge to get healthy food for own consumption and attraction to healthy chemical free farming.***

Figure 2.2: Distribution of the primary occupations of APCNF & Non-APCNF sample farmers

In percentages



Sources: Field Survey, 2019-20

2.5. Gender distribution of the sample

Out of total 1,422 APCNF sample farmers, nearly 10 per cent are female farmers. The same is less than 6 per cent among non-APCNF farmers. It once again establishes the RySS's focus on the vulnerable sections. The district wise, gender wise distribution of the sample farmers is presented at Table 2.3. Among the APCNF sample farmers, female farmers' proportion is highest in PRS Nellore(30 per cent), followed by Srikakulam (18.60 per cent), Kurnool (13.88 per cent), Prakasam (13.11 per cent) and so on.

Table 2.3: District wise distribution of gender category wise APCNF and Non-APCNF of sample (in percentage)

District	APCNF			Non - APCNF		
	Male	Female	Total	Male	Female	Total
Anantapuramu	93.94	6.06	100	98.00	2.00	100
Chittoor	93.44	6.56	100	90.00	10.00	100
East Godavari	89.90	10.10	100	94.00	6.00	100
Guntur	94.00	6.00	100	98.00	2.00	100
YSR Kadapa	93.18	6.82	100	98.00	2.00	100
Krishna	95.76	4.24	100	100.00	-	100
Kurnool	86.12	13.88	100	94.90	5.10	100
PSR Nellore	69.57	30.43	100	95.00	5.00	100
Prakasam	86.89	13.11	100	83.33	16.67	100
Srikakulam	81.40	18.60	100	86.00	14.00	100
Visakhapatnam	95.04	4.96	100	96.00	4.00	100
Vizianagaram	92.19	7.81	100	88.00	12.00	100
West Godavari	93.94	6.06	100	96.00	4.00	100
AP	90.30	9.63	100	94.43	5.73	100

Sources: Field Survey, 2019-20

2.6. Land ownership and cultivation

Out of total 1,422 sample APCNF farmers, 6.54 per cent are landless/ pure lease in farmers, 45.15 per cent are marginal farmers, 33.05 per cent are small farmers and 15.26 per cent are other farmers, who own more than 2 ha (Table 2.4). The distribution of APCNF and non-APCNF is almost same. The landless, marginal, and small farmers together constitute about 85 per cent in both sets of farmers. The major difference is that marginal farmers are less by 5 per centin APCNF sample compared to non-APCNF sample. It is vice versa in small farmers. One possible reason is that marginal farmers, who derive much less proportion of the family income from farming; may be devoting less attention to the farming. APCNF, which needs more attention and efforts from the family labour, may be less popular among the marginal-farmers vis-à-vis small farmers.

Table 2.4: District-wise farmers'categories-wise distribution of APCNF and non-APCNF sample farmers

In percentages

District	APCNF					Non-APCNF				
	Landless	Marginal	Small	Others	Total	landless	Marginal	Small	Others	Total
Anantapuramu	3.03	19.19	48.48	29.29	100	-	12.00	62.00	26.00	100
Chittoor	-	72.13	26.23	1.64	100	-	76.67	23.33	-	100
East Godavari	19.19	29.29	26.26	25.25	100	12.00	50.00	20.00	18.00	100
Guntur	18.00	57.00	20.00	5.00	100	24.00	42.00	28.00	6.00	100
YSR Kadapa	5.30	31.82	43.94	18.94	100	6.00	32.00	44.00	18.00	100
Krishna	5.93	59.32	21.19	13.56	100	2.00	62.00	30.00	6.00	100
Kurnool	6.22	30.62	41.15	22.01	100	4.00	37.00	25.00	34.00	100
PSR Nellore	-	69.57	17.39	13.04	100	-	35.00	25.00	40.00	100
Prakasam	6.56	42.62	31.15	19.67	100	-	53.33	36.67	10.00	100
Srikakulam	3.10	52.71	35.66	8.53	100	4.00	74.00	16.00	6.00	100
Visakhapatnam	1.42	51.06	38.30	9.22	100	-	58.00	28.00	14.00	100
Vizianagaram	3.91	52.34	34.38	9.38	100	6.00	78.00	14.00	2.00	100
West Godavari	11.11	52.53	20.20	16.16	100	4.00	64.00	26.00	6.00	100
AP	6.54	45.15	33.05	15.26	100	5.24	50.63	28.89	15.24	100

Sources: Field Survey, 2019-20

All the APCNF sample farmers together own 1,944.44 ha land and have cultivated 2,044.98 during the study season. Out of the total cultivated area, the APCNF farmers have devoted nearly 55 per cent of area to APCNF method of farming (Table 2.5). One interesting point to be noted is that landless or pure lease-in farmers have put over 71 per cent of their operational area under APCNF. The same is 67.95 per cent for marginal farmers, 58.96 per centfor small farmers and 40.21 per cent for other farmers (medium and large farmers). This finding dismantles the; often heard; assertion that natural farming is a hobby of the rich farmers. It demonstrates that APCNF is becoming popular among marginal and small farmers, particularly among the lease-in farmers. On an average, while the APCNF farmers own a little more area (1.37 ha) vis-à-vis non-APCNF farmers (1.31 ha), they cultivate relatively less area (1.44 ha) compared to non-APCNF farmers (1.53 ha). One of the possible reasons is that the incidence of landless/ lease-in farmers is relatively high among APCNF farmers; by more than one percentage point.

Table 2.5: Farmer category-wise total and average area owned, cultivated and area put under APCNF by APCNF farmers

In ha and percentages.

Farmer Category	Total Area Owned		Total Area Cultivate		Area under APCNF		Percentage area under APCNF	
	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF
Landless	-	-	74.20	45.38	53.03	-	71.47	-
Marginal	408.45	200.90	502.57	278.70	341.51	-	67.95	-
Small	706.63	277.15	735.20	307.22	433.48	-	58.96	-
Others	821.38	341.84	733.02	332.55	294.77	-	40.21	-
All	1,944.66	824.35	2,044.98	963.86	1,122.80	-	54.90	-
	Average area							
Landless	-		0.80	1.42	0.57	-	71.47	-
Marginal	0.64	0.63	0.78	0.87	0.53	-	67.95	-
Small	1.50	1.52	1.56	1.69	0.92	-	58.96	-
Others	3.79	3.56	3.38	3.46	1.36	-	40.21	-
All	1.37	1.31	1.44	1.53	0.79	-	54.90	-

Sources: Field Survey, 2019-20

District wise analysis of the land ownership, cultivated area, and area allocated for APCNF and percentage area put under APCNF gives very interesting results. Chittoor district with lowest ownership and operational holding sizes has allocated highest percentage (85.30 per cent) of operational area to APCNF. On the other hand, Anantapuramu with highest average ownership holding size (2.06 ha) and Kurnool district with highest average operational holding size (2.20 ha) have second and third highest positions in terms of per cent area allocated for APCNF (Table 2.6). On the other hand, only 34.76 per cent cultivated area in Krishna district is allocated for APCNF, preceded by East Godavari (40.78 per cent), West Godavari (40.93 per cent) and Srikakulam (40.98 per cent). APCNF appeared to be more acceptable in southern part of the state, especially in Rayalaseema, which has relatively lesser irrigated area, lesser rainfall, and drought prone. In contrast the delta and north costal districts, which have rich soils, higher proportion of irrigated area and high rainfall, are less receptive to the APCNF. The reasons could be the cultural factors. The farmers in the drought prone areas under rainfed conditions, especially in Rayalaseema, adopt risk aversion agriculture strategies, i.e. invest very less in agriculture due to uncertainties with respect to crop yields and marketing and shortage of investable funds. APCNF, being low cost farming method, is gaining popularity in southern part, especially in Rayalaseema. Out of total 13

districts, only in five districts, the per cent of cultivated area under APCNF is higher than the state average of 54.90 per cent. Out of these five districts, four are from southern part and three are from Rayalaseema.

Table 2.6: District-wise average area owned, cultivated and put under APCNF by APCNF farmers

In hectares

Farmer Category	Area Owned		Area Cultivate		Area Under APCNF		Per cent Area under APCNF	
	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF
Chittoor	0.98	0.84	0.97	0.83	0.83	-	85.30	0
Anantapuramu	2.10	2.06	1.65	1.66	1.28	-	77.17	0
Kurnool	1.69	1.84	1.81	2.20	1.31	-	72.28	0
Visakhapatnam	1.13	1.23	1.18	1.23	0.81	-	68.64	0
Prakasam	1.49	1.31	1.44	2.18	0.81	-	56.04	0
YSR Kadapa	1.48	1.47	1.32	1.33	0.65	-	49.61	0
Vizianagaram	1.07	0.73	1.13	0.69	0.56	-	49.42	0
PSR Nellore	1.41	2.81	1.39	3.40	0.66	-	47.72	0
Guntur	1.03	0.83	1.38	1.42	0.60	-	43.25	0
Srikakulam	1.08	0.80	1.16	0.98	0.48	-	40.98	0
West Godavari	1.17	1.03	1.54	1.27	0.63	-	40.93	0
East Godavari	1.60	1.20	1.66	1.98	0.68	-	40.78	0
Krishna	1.35	1.05	1.72	1.15	0.60	-	34.76	0
A P	1.37	1.31	1.44	1.53	0.79	-	54.90	0

Sources: Field Survey, 2019-20

2.7. Experience in APCNF

Though APCNF is launched in 2016, the same program, known as Community Managed Sustainable Agriculture (CMSA), is implemented in the state to a limited extent through Self-Help Groups (SHGs) institutions by the Society for Elimination of Rural Poverty (SERP). More than six per cent APCNF sample started natural forming before 2015; some of them have about 20 years of experience. However, more than 70 per cent have started in 2016 and 2017. About 20 per cent have started in 2018 and only 3 per cent have started in 2019 (Table 2.7). Southern districts of Anantapuramu, Guntur, Prakasam and YSR Kadapa have relatively more farmers with longer experience in the natural farming. That may be one of the reasons for allocation of larger per cent of operational holding to APCNF in this region. Majority of sample farmers from Chittoor, Vizianagaram and Visakhapatnam have four years of experience in the natural farming. In the delta districts, most of the farmers are new

Table 2.7: District-wise APCNF start year-wise distribution of APCNF sample farmers

In percentages

District	Before 2016	2016	2017	2018	2019	Total
Anantapuramu	16.16	21.21	39.39	22.22	1.01	100.00
Chittoor	3.28	81.97	13.11	1.64	-	100.00
East Godavari	5.05	34.34	30.30	18.18	12.12	100.00
Guntur	15.00	32.00	30.00	19.00	4.00	100.00
Krishna	4.24	29.66	48.31	16.10	1.69	100.00
Kurnool	2.87	21.05	33.97	41.63	0.48	100.00
Prakasam	13.11	42.62	32.79	8.20	3.28	100.00
PSR Nellore	4.35	23.91	60.87	8.70	2.17	100.00
Srikakulam	1.55	36.43	43.41	17.05	1.55	100.00
Visakhapatnam	4.26	63.12	28.37	2.84	1.42	100.00
Vizianagaram	3.13	69.53	25.00	1.56	0.78	100.00
West Godavari	3.03	12.12	27.27	47.47	10.10	100.00
YSR Kadapa	12.12	18.94	40.15	25.00	3.79	100.00
Andhra Pradesh	6.33	36.22	34.53	19.90	3.02	100.00

Sources: Field Survey, 2019-20

2.8. Crop wise samples

The major objective of the study is to compare the cost of cultivation, yields, gross and net returns of different crops cultivated under APCNF and conventional (non-APCNF) methods. In this report, the analysis is limited to 13 crops. The study has collected 1,701 records of 13 crops cultivated under APCNF method and 853 records of the same crops cultivated under non-APCNF method (Table 2.8). It implies that some of the farmers have cultivated more than one crop. In other words, the 1,422 sample APCNF farmers have reported 1,701 cropping details and 628 non-APCNF farmers have reported 853 crop records. On an average, each APCNF farmer has cultivated 1.2 crops and each and non-APCNF farmer has cultivated 1.36 crops during Kharif 2019. Broadly, with increase in cultivated area, the crop diversity has also increased, with one exception. It appears that APCNF farmers have less crop diversity vis-à-vis non-APCNF farmers. However, it should be remembered that APCNF farmers have put only 55 per cent of their cultivated area under APCNF methods. Their crop diversity would have been higher, had their entire cultivated area is considered.

With 787 APCNF and 367 non-APCNF crop records, Paddy has highest sample size. Onion with 34 APCNF crop records and 17 non-APCNF crop records has the lowest sample size. More farmers grow Paddy than Onion. The sample size of all crops is adequate to provide the comparative estimates of cost of cultivation, yields, gross and net returns at the state level. The sample size of Paddy and Cotton are adequate to provide reliable estimates at district

level and other levels such irrigation status, etc. Maize, Red gram and Groundnut have adequate sample size to provide moderately reliable comparative picture at disaggregate levels. The sample size of other crops is sufficient to provide only anecdotal evidence.

Table 2.8: Crop-wise and farmer category-wise distribution of APCNF and non-APCNF sample data

In numbers

Crop name	Landless		Marginal		Small		Others		Total	
	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF
Paddy	57	21	371	205	254	94	105	47	787	367
Maize	4	1	34	35	25	8	13	9	76	53
Groundnut	2	0	36	11	53	25	29	15	120	51
Cotton	5	4	53	46	33	22	16	13	107	85
Chillies	3	2	12	19	15	12	6	6	36	39
Blackgram	8	1	23	7	24	4	9	7	64	19
Bengalgram	2	0	20	18	27	25	21	10	70	53
Jowar	2	2	25	11	35	8	14	18	76	39
Ragi	0	0	33	11	47	9	9	5	89	25
Redgram	4	1	38	21	56	18	18	18	116	58
Sugarcane	3	0	46	23	16	6	5	1	70	30
Onion	3	2	9	8	20	5	2	2	34	17
Turmeric	3	3	25	4	25	4	3	6	56	17
Total crops	96	37	725	419	630	240	250	157	1,701	853
Total farmers	93	32	642	318	470	182	217	96	1,422	628
Crops per farmers	1.03	1.16	1.13	1.32	1.34	1.32	1.15	1.64	1.20	1.36

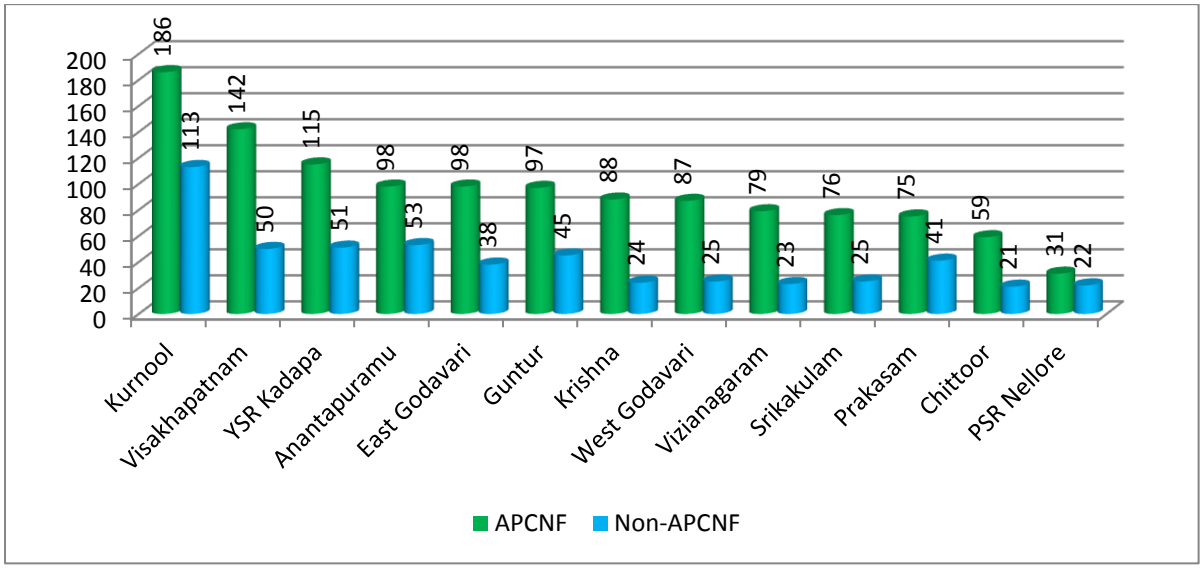
Sources: Field Survey, 2019-20

2.9. Crop cutting experiments

One of the major activities of this study is to collect yield data through crop cutting experiments (CCEs) independently and scientifically. Total 1,732 crop cutting experiments were conducted during the study period. These include 1,232crop cutting experiments of APCNF crops and 531 experiments of non-APCNF crops. District wise number of CCEs conducted is shown at Figure 2.3. Among the APCNF crops highest numbers of CCEs (186) were conducted in Kurnool followed Visakhapatnam (142) and YSR Kadapa (115). Least number of CCEs (31) were conducted in PSR Nellore district, followed by Chittoor (59) and Prakasam (75) districts. As mentioned above, the study has collected more samples from Kurnool and north costal districts and fewer samples from southern districts of Prakasam, PSR Nellore and Chittoor, owing to variations in the progress of the APCNF project implementation and other reasons. In case of non-APCNF crops, highest number of CCEs (113)were conducted in Kurnool, followed by Anantapuramu (53) and YSR Kadapa (51) districts. Least number of CCEs (21) were conducted in Chittoor, followed by PSR Nellore (22) and Vizianagaram (23) districts.

Figure 2.3: District-wise number of APCNF and Non-APCNF CCEs conducted

In numbers



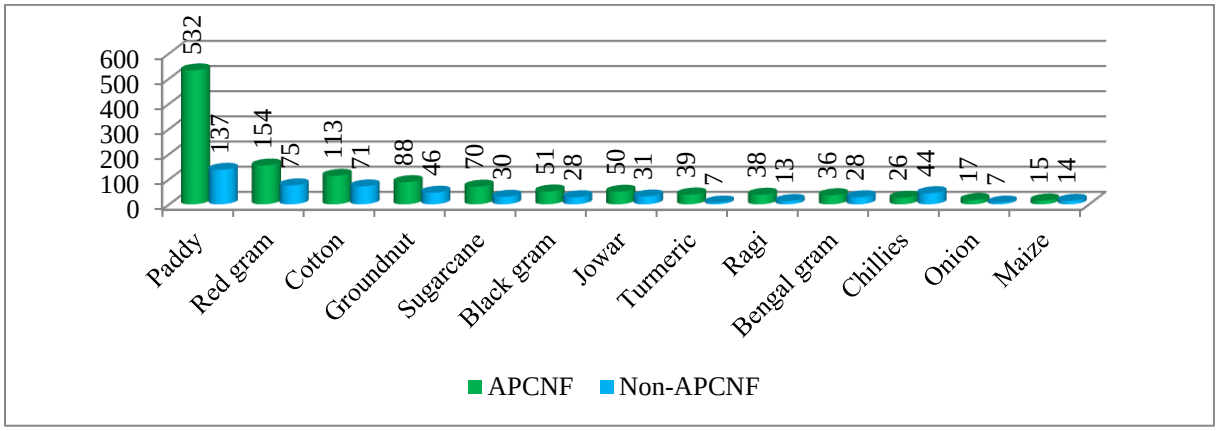
Sources: Field Survey, 2019-20

Out of total 1,232 APCNF, CCEs, two single CCEs of two crops, viz. vegetables and Sesamum were dropped from the analysis in this report. Crop wise number of CCEs conducted is shown in the Figure 2.4. In the total CCEs of APCNF, Paddy alone constitutes 43 per cent. Three crops, viz. Paddy, Red gram and Cotton together cover nearly two-thirds of total CCEs of APCNF crops. On the other hand, Maize, Onion and Chillies have fewer numbers of CCEs. Among the CCEs of non-APCNF crops, three crops, viz. Paddy, Red gram and Cotton together constitute more than 50 per cent. On the other hand, Onion and Turmeric has less than 10 CCEs each, and Ragi and Maize have just above 10 CCEs. One of the reasons for such skewed data is the late start of the study.2 In the future, such skewed data collection should be avoided. Using the reported yields and yields obtained through CCEs, the correction factors were estimated. These correction factors were used wherever necessary to get reliable comparative picture between APCNF and Non-APCNF cultivation.

Figure 2.4: Crop-wise number of APCNF and non-APCNF CCEs conducted

In numbers

[2] The field survey has begun on 19th November 2019. By that time some of the Kharif crops were harvested; there is no scope for CCEs in those crops.

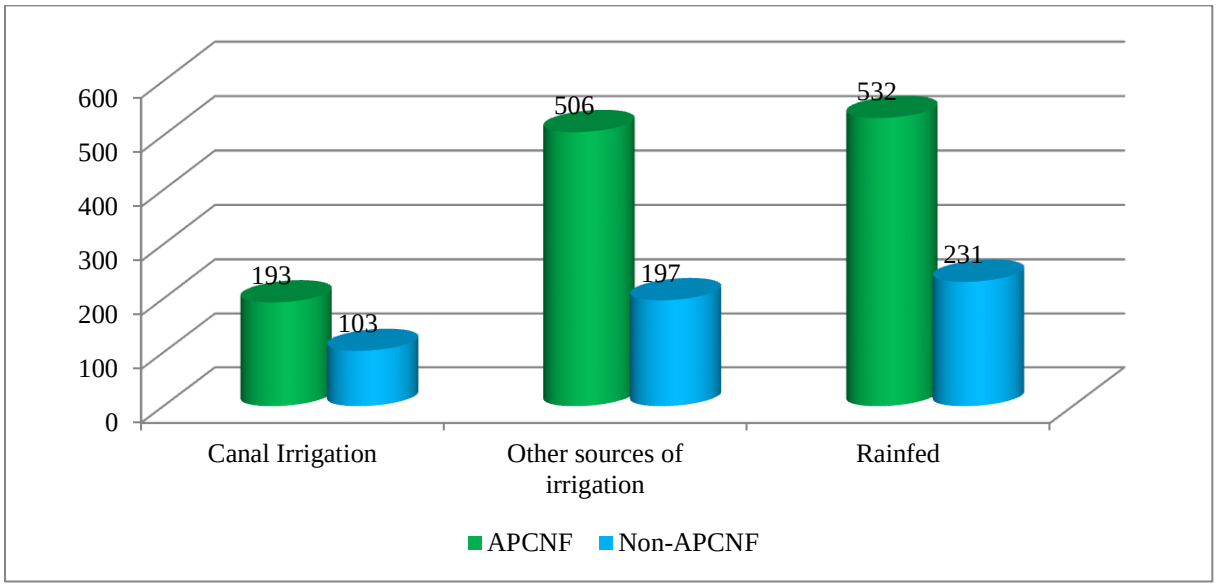


Sources: Field Survey, 2019-20

Over 56 per cent of total CCEs were conducted among the irrigated crops. The proportion is same for both APCNF and Non-APCNF crops. Within irrigation crops, overwhelming majority of crops were irrigated through other sources of irrigation, which includes bore-wells, dug-wells, tanks, streams and lift irrigation (Figure 2.5). One of the possible reasons for higher proportion of irrigated crops is the inclusion of early Rabi crops in the CCEs. Predominance of other sources irrigation confirms the inclusion of early Rabi crops. Normally canal irrigation is predominant mode of irrigation during the Kharif season in the state.

Figure 2.5: Irrigation source-wise number of APCNF and non-APCNF CCEs conducted

In numbers



Sources: Field Survey, 2019-20

2.10. Conclusions

The profile of the sample farmers clearly indicates that RySS has been focusing on the poor and vulnerable sections. The presence of SC, ST, women farmers and landless/ leased-in farmers is higher among APCNF sample, vis-à-vis control sample. Higher proportion of literates and educated farmers, youth, and professionals among the project-APCNF sample indicates that APCNF is gaining popularity among the educated or informed farmers, youth and professionals. Contrary to the popular perceptions and deliberately propagated assertions that natural farming is a hobby of the rich, the small and marginal farmers, including leased-in farmers have allocated larger parts of their holdings to APCNF vis-à-vis medium and large farmers. The southern districts, especially Rayalaseema, have allocated larger portion of their operational holdings to APCNF. APCNF, the low cost of cultivation model is gaining acceptance in the southern part, where farmers usually adopt risk averse low investment agriculture strategies. Another reason could be that the southern districts have longer experience in the natural farming. Though the sample sizes for some crops were small, reliable estimates were obtained through correction factors. Using the reported yields and yields obtained through CCEs, the correction factors were estimated. These correction factors were used wherever necessary to get reliable comparative picture between APCNF and Non-APCNF cultivation.

Chapter 3: Impact of APCNF on Crop Production Conditions

3.1. Introduction

This chapter covers the analysis of cost of plant nutrients and protection inputs (PNPIs),i, total paid out cost of cultivation of different crops, crop yields, and crop wise gross and net returns.

3.2. Plant Nutrients and Protection Inputs

The principal intervention of the APCNF is the introduction of biological inputs such as Beejamrutham, Ghanajeevamrutham and Dravajeevamrutham in place chemical fertilizers; and Kashayams and Asthrams in place of pesticides and vermicides. These biological and chemical inputs together are referred, in this report, as plant nutrient and protection inputs (PNPIs). The crop wise variations between the biological inputs' costs, in APCNF, and chemical inputs costs, under Non-APCNF, during Kharif 2019-20, are presented at Table 3.1. Among the 13 sample crops analysed during Kharif, the chemical inputs costs, under Non-APCNF or conventional model, vary from ₹3,301 per hectare in Ragi to,₹93,359per hectare in Chillies. The per hectare cost of PNPI is more than ₹40,000 in two other crops, viz. Turmeric and Onion; more than ₹25,000 in Cotton and more than ₹10,000 in six other crops. At the same time, the costs of biological inputs under APCNF have varied from ₹3,922 per hectare in Ragi to ₹15,103per hectare in Turmeric (Table 3.1). In absolute terms, by adapting to the biological inputs, the farmers have saved ₹986 per hectare in Jowar to ₹83,359 per hectare in Chillies in PNPIs due to APCNF. The farmers have saved more than ₹30,000 per ha in two crops, viz. Turmeric and Onion. The farmers have incurred ₹9,279 less per ha in PNPIs in Paddy, the principal crop in the state. In another principal crop, Bengal gram, the farmers have incurred ₹8,085 less per ha on PNPIs, due to APCNF. On the other hand, the farmers have incurred ₹620 more per ha on PNPIs in Ragi. In relative terms, the cost of biological inputs is less than that of chemical inputs by 12.59 per cent in Groundnut to 89.87 per cent in Chillies. Out of total 13 crops, in eight crops, the reduction in the expenditure on PNPIs is more than 50 per cent. The same is more than 40 per cent in two crops and more than 10 per cent in two other crops. However, in Ragi the expenditure on PNPIs has increased by 18 per cent. It may be worth noting, that as the farmers under rainfed conditions invest very little in agriculture, including on chemical fertilizers and pesticides, the savings in the

expenditure on PNPIs due to APCNF appears to be impressive in percentage terms, but not so impressive in absolute terms in many crops.

Table 3.1: Crop wise expenditure on PNPIs under APCNF and non-APCNF & differences

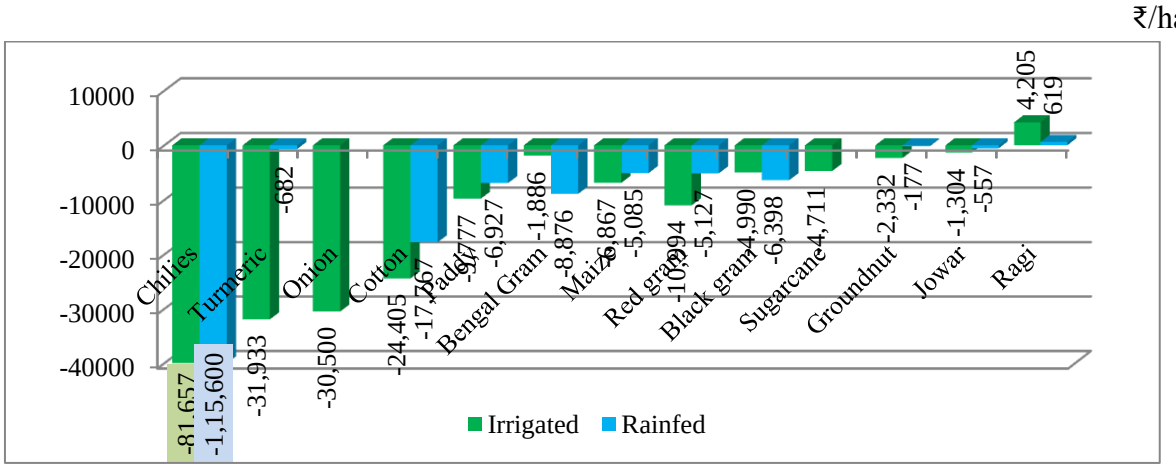
₹/ha

Crop	Biological inputs in APCNF	Chemical inputs in Non-APCNF	Difference in Rs	Differences in percentages
Chillies	9,454	93,359	-83,905	-89.87
Turmeric	15,103	46,788	-31,685	-67.72
Onion	10,497	40,997	-30,500	-74.40
Cotton	6,462	25,471	-19,009	-74.63
Paddy	5,035	14,330	-9,295	-64.86
Bengalgram	4,874	12,958	-8,085	-62.39
Maize	5,124	11,838	-6,715	-56.72
Redgram	4,393	10,672	-6,279	-58.83
Blackgram	6,206	11,953	-5,746	-48.08
Sugarcane	6,179	10,890	-4,711	-43.26
Groundnut	6,994	8,001	-1,007	-12.59
Jowar	6,015	7,001	-986	-14.08
Ragi	3,922	3,301	620	18.80

Sources: Field Survey, 2019-20

As mentioned in chapter two, that given the sample sizes of most of the crops, the sub-state and sub-crop analyses give only rough figures for some crops and data are not reliable. The crop wise changes in the expenditure on PNPIs under irrigation and rainfed conditions and district wise changes in the Paddy crop are shown below. The crop wise variations in the expenditure on PNPIs under irrigation and rainfed conditions are presented at Figure 3.1. Baring a few exceptions, the reduction in the expenditure on PNPIs is less under the rainfed conditions for most of the crops. It is obvious; as the farmers, under conventional methods of cultivation, invest less under the rainfed conditions, the scope for the reduction in the expenditure on PNPIs is less compared to that of irrigated conditions.

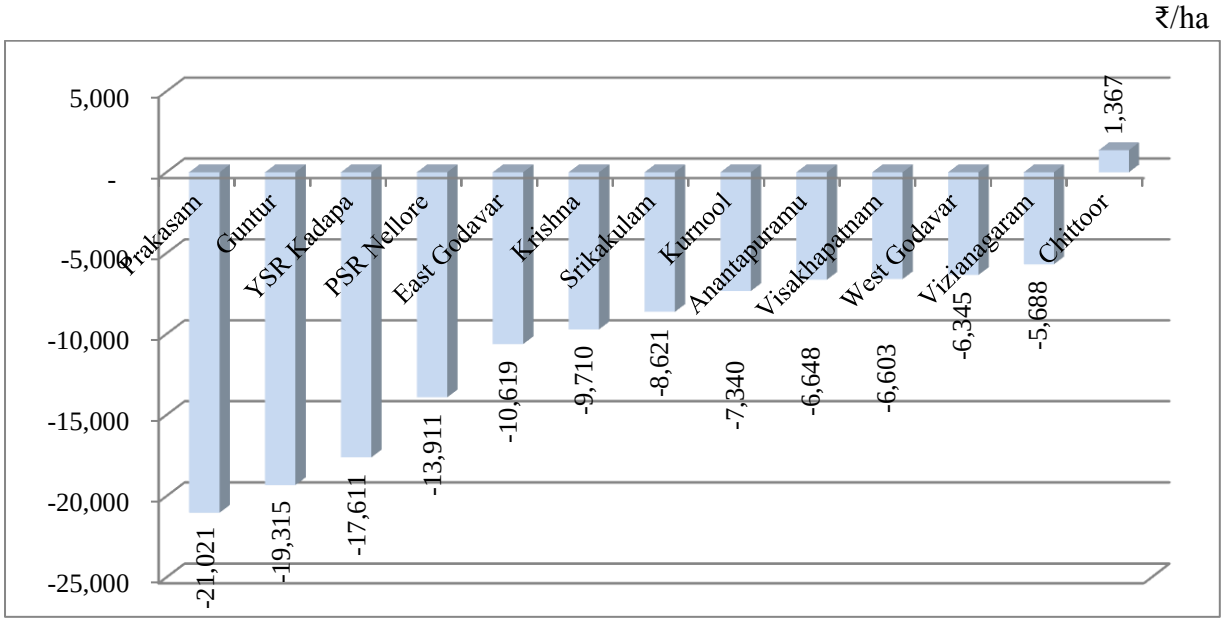
Figure 3.1: Crop-wise changes in expenditure on PNPIs under irrigation and rainfed conditions due to APCNF



Sources: Field Survey, 2019-20

The district wise changes in the expenditure on PNPIs in Paddy are presented in Figure 3.2. The expenditure on PNPIs in Paddy has decline in 12 out of total 13 districts in the state; the only exception is Chittoor. The expenditure has declined from ₹5,688 per ha in Vizianagaram to ₹21,021 per ha in Prakasam district. It may be noted that out of five districts, in which the expenditure has declined by more than ₹10,000 per ha, the top four are from southern part of the state.

Figure 3.2: District-wise changes in the expenditure on PNPIs in Paddy due to APCNF



Sources: Field Survey, 2019-20

3.3. Total paid out cost of cultivation and cost composition

As the cost of biological inputs are considerably lower than their counterparts, i.e. fertilizers and pesticides, in all but one crop, the total paid out cost of cultivation per hectare is expected to be lower across all the crops under APCNF compared to Non-APCNF. The total paid out costs in each of 13 sample crops under APCNF and Non-APCNF and their differences are shown in (Tables 3.2). In absolute terms, the highest reduction (difference) in total paid out costs ₹62,243 per ha is obtained in Turmeric followed by ₹61,320 per ha in Chillies and ₹42,248 per ha in Onion. On the other hand, least reduction of ₹480 per ha is obtained in Jowar, followed by Groundnut (₹4,718 per ha) and Black gram (₹6.718 per ha). The total paid out cost of cultivation of Sugarcane under APCNF is higher that of non-APCNF. The major reason is that some of APCNF farmers have made Jaggary from sugarcane and reported their additional costs of human labour, machinery, and transport costs in the cost of production. **It is worth noting here, that except in Chillies, the savings realized in total paid out costs is higher than the savings obtained in the expenditure on PNPIs in all the other crops.** Ragi is one good illustration; while expenditure on PNPIs in APCNP is higher than that of non-APCNF by ₹620 per ha, the total cost has reduced by ₹10,001 per ha. It is in contrast to the earlier trends observed and reported in the previous reports. **The possible reasons could be the increase in the soil quality under APCNF**. Last year the farmers, in the case studies, have reported that the soils have softened under APCNF and there is less/ no need for plough the soils in the middle of the season. The moisture retention characteristics of soil might have also improved, reducing the frequency and quantity of the irrigations. **As per the APCNF sample farmers' response, about 91 per cent of their irrigated area has adequate irrigation; the same is about 88 per cent for non-APCNF sample.**

In terms of rate of change/ reduction, the highest reduction in total cost of cultivation under APCNF is 41.93 per cent in Ragi, closely followed by Onion (39.07 per cent), and Cotton (35.97 per cent). The least reduction is 1.89 per cent in Jowar, followed by, Groundnut (9.08 per cent) and Maize (18.47per cent). Out of total 13 sample crops, in six crops the total paid out cost has declined by over 30 per cent; in two crops the reduction is, over 20 per cent; in another two crops, it is just below 20 per cent. Only in Sugarcane, the total cost of cultivation is higher under APCNF by 12.72 per cent; due to inclusion of the post-harvest processing and transport costs.

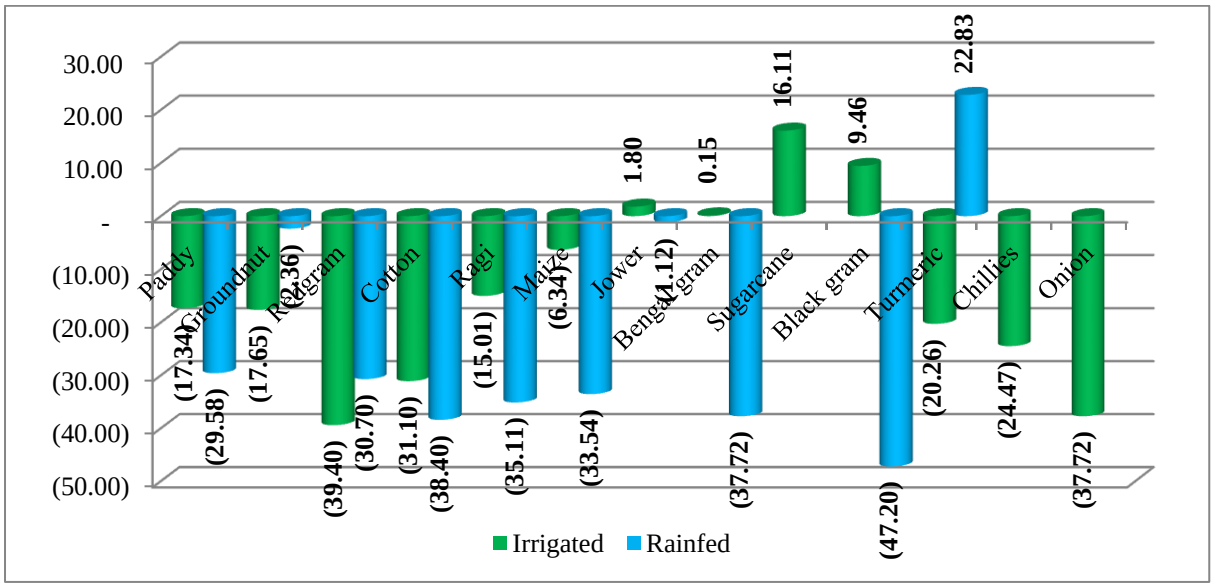
Table 3.2: Crop wise total paid out costs under APCNF and Non-APCNF and changes (Rs/ha)

Crop	Total cost under APCNF	Total cost under Non-APCNF	Changes in costdue to APCNF in ₹	Changes in costdue to APCNF in %
Turmeric	1,36,778	1,99,021	-62,243	-31.27
Chillies	1,76,592	2,37,912	-61,320	-25.77
Onion	65,877	1,08,125	-42,248	-39.07
Cotton	46,445	72,539	-26,094	-35.97
Bengal gram	32,197	48,377	-16,181	-33.45
Ragi	13,849	23,850	-10,001	-41.93
Paddy	40,734	50,429	-9,694	-19.22
Redgram	18,164	27,233	-9,069	-33.30
Maize	37,554	46,063	-8,509	-18.47
Blackgram	26,036	32,753	-6,718	-20.51
Groundnut	47,047	51,745	-4,698	-9.08
Jowar	24,943	25,424	-480	-1.89
Sugarcane	1,12,305	99,630	12,676	12.72

Sources: Field Survey, 2019-20

In the Figure 3.3, the rate of changes in total cost of cultivation, due to APCNF, under irrigated and rainfed condition have been shown. As mentioned above, the sample sizes in some crops are not sufficient to provide reliable sub-crop scenario. In the figure the crops were arranged as per the sample size of APCNF. In the crops with larger sample sizes such as Paddy, Groundnut, Red gram, Cotton, etc., the trend is clear and consistent under both irrigated and rainfed conditions. In the crops with smaller samples such as Black gram and Turmeric, the trends are inconsistent. . Sample size is not necessarily the only influencing factor. There may be other factors for the observed inconsistency. The reduction in total cost of cultivation is larger under rainfed conditions compared to irrigated condition for most of the crops. This trend is quite opposite to the trend observed in the expenditure on PNPIs. The reason is obvious. The farmers use more agro-chemicals under irrigation; hence larger savings in PNPIs is possible there. As mentioned above the improved soil might have reduced some operational costs such as ploughing under the rainfed conditions. Some increase in operational costs related to increase in yields may be possible under irrigation conditions.

Figure 3.3: Crop-wise changes in total cost of cultivation under irrigation and rainfed conditions due to APCNF and Non-APCNF

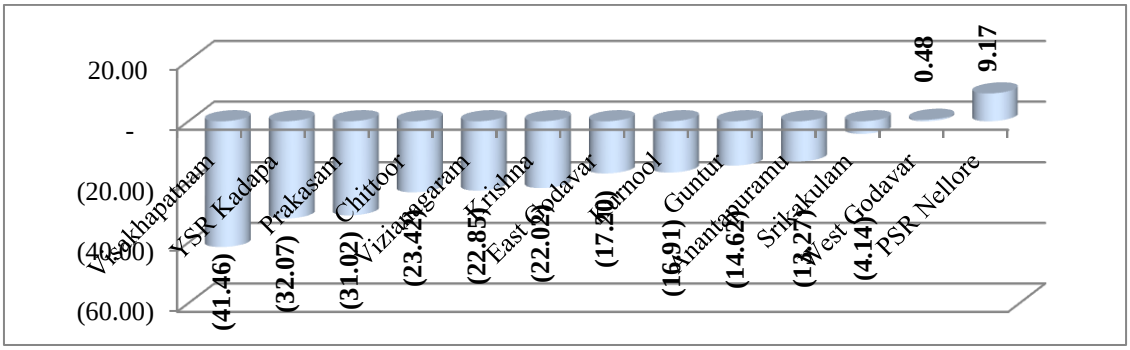


Source: Field Survey, 2018-19

District wise changes in the total cost of cultivation of Paddy due to APCNF have been presented at Figure 3.4. Out of total 13 districts, 11 have recorded notable decline in total cost of cultivation of Paddy. The reduction in the total cost is highest in Visakhapatnam (41.46 per cent), followed by YSR Kadapa (32.07%), Prakasam (31.02%) and so on. The least reduction is obtained in Srikakulam (4.14%). While there is no change in West Godavari district, the total cost of cultivation of Paddy has increased in PSR Nellore by 9.17. The inter-district variations in total cost of cultivation of Paddy may partly reflect the performance of the RySS district teams.

Figure 3.4: District-wise changes in total cost of cultivation of Paddy, due to APCNF

In percentages



Sources: Field Survey, 2019-20

The above analysis indicates, that the rates of reduction in the cost of PNPIs of each crop did not correspondingly reflect in the total paid out costs of the respective crop. It implies that there must be some variations in the expenditure on other inputs. The variations in expenditure, under APCNF and Non-APCNF, on major inputs during Kharif season are shown at Table 3.3. Only purchased and leased inputs are considered in this analysis.[3]The inputs considered in this analysis are Seeds, PNPIs, FYM, Hired labour, Bullock labour, Machine labour, Implements and Water fee. In each crop, the expenditure on majority inputs has declined under APCNF vis-à-vis non-APCNF. The expenditure on seeds has declined in nine crops out of total 13 crops considered. The same is 12 out of 13 in PNPIs, eight in FYM, 10 in hired labour, eight in Bullock labour, 10 in Machine labour, seven in Implements and five in Water fee. The highest reduction in the expenditure on seed is ₹5,828 per ha in Groundnut; the same in PNPIs is ₹83,905 in Chillies; in FYM it is ₹6,288 per ha in Turmeric; in Hired labour it is Rs13,004 per ha in Turmeric; in Bullock labour it is ₹2,924 per ha in Turmeric; in Machine labour, it is ₹7,613 per ha in Turmeric; in Implements, it is ₹3,718 per ha in Turmeric; and in Water fee, it is ₹1,683 per ha in Onion. Notable increase in the expenditure on certain inputs in a few crops is also observed. These include ₹20,214 per ha on Hired labour in Chillies; ₹11,855 per ha on Machine labour in Sugarcane; and ₹6,053 per ha on Water fee in Chillies. As mentioned elsewhere in this report that increase in expenditure on agriculture inputs, especially on the hired labour for harvesting and other related activities of increased crop output is desirable. As can be seen in the next section, that Chillies yield under APCNF is substantially higher than that of non-APCNF; which necessitated additional expenditure on hired labour and irrigation. As mentioned elsewhere in the report that some of APCNF Sugarcane farmers have made Jaggary, which has resulted in the additional expenditure on hired labour, machinery extracting the sugarcane juice and transport of Jaggary. Other increases in expenditure on agriculture inputs were small amounts.

Table 3.3: Differences in expenditure on major purchased agriculture inputs under APCNF and Non-APCNF

in ₹ per ha

Crop	Seed	PNPIs	FYM	Hired labour	Bullock labour	Machine labour	Implements	Water fee
Paddy	-156	-9,295	592	-588	-63	-304	-198	318
Maize	-351	-6,715	605	-227	-104	-1,113	-95	-508
Groundnut	-5,828	-1,007	-290	3,893	-523	-745	-158	-41
Cotton	-811	-19,009	912	-6,398	-503	167	-536	84

[3] In this analysis, the rent paid out on lease in land is not included.

Chillies	-2,661	-83,905	1,843	20,214	840	-4,288	584	6,053
Block gram	402	-5,746	-356	-455	403	-1,364	163	235
Bengal gram	-1,259	-8,085	-137	-5,803	-31	-255	-701	90
Jowar	-0	-986	-553	-195	743	481	30	0
Ragi	48	620	-333	-7,052	-1,344	-2,023	125	-42
Red gram	-43	-6,279	379	-1,761	-180	-1,034	-117	-33
Sugarcane	1,092	-4,711	-974	2,509	867	11,855	1,546	493
Onion	-2,463	-30,500	-87	-7,019	1,240	-1,896	160	-1,683
Turmeric	2,440	-31,685	-6,288	-13,004	-2,924	-7,613	-3,718	550
No. of declines	9/13	12/13	8/13	10/13	8/13	10/13	7/13	5/13
Max of above	**2,440**	**620**	**1,843**	**20,214**	**1,240**	**11,855**	**1,546**	**6,053**
Min of above	*-5,828*	*-83,905*	*-6,288*	*-13,004*	*-2,924*	*-7,613*	*-3,718*	*-1,683*

Source: Field Survey, 2018-19

3.4. Crop Yields

There is a lot of interest among different stakeholders, to know the impact of APCNF on crop yield. The development literature broadly indicates some fall in the crop yields under organic farming and other forms of natural farming, at least in the initial years. However, unlike the other models of natural farming, APCNF is facilitating a quick / instant revival of soils through the incorporation of microorganisms. Hence it expects no significant variations in the crop yields in the initial periods and expects higher yields over the years. There are some apprehensions among farming communities about the falling yields and/ or low crop yields under APCNF. To know the crop yields through third party, RySS has mandated the study to conduct the crop cutting experiments (CCEs) independently and scientifically. Another reason for undertaking the CCEs is to overcome the strategic biases of the farmers. In India, in general, all the people usually underreport their incomes and wealth/ assets. This phenomenon is more conspicuous in the rural areas and agriculture sector. There are some potential reasons for the APCNF farmers to underreport their yields. The possible reasons include dissuading their fellow farmers from adopting the APCNF and gaining the monopolistic advantages in the market; to gain the premium prices for their output; to discourage the landowners from increasing the land rent; etc.

The estimated yields of 13 sample crops under APCNF and Non-APCNF and differences between them in absolute and per cent terms are given at Table 3.4. Out of 13 crops covered in the season, 10 crops have higher yields under APCNF. The increase is in the range- from 0.15 quintals in Groundnut to 18.24 quintals in Onions. The yields have declined in three

crops, from 0.57 quintals per ha in Cotton to 8.82 quintals per ha Sugarcane. Highest increase due to APCNF is 18.24 quintals per ha in Onion, followed by 11.08 quintals per ha in Turmeric and 4.10 quintals per ha in Chillies. Out of 13 sample crops, in three crops, viz. Paddy, Chillies, and Black gram, the variations in the yields are statistically significant. In all these three crops, including the Paddy, the principal crop in the state, the APCNF yields are higher than that of non-APCNF yields..

In percentage terms, the increases in crop yields due to APCNF vary from 0.94% in Groundnut to 23.28% in Ragi. The highest increase due to APCNF is 23.28 per cent in Ragi, followed by Black gram (23.24%) and Jowar (10.41%). In the remaining crops, the yields are higher by 10% in two crops, about 9% in one crop and about 6% in two crops. While Sugarcane (1.70%) and Cotton (2.92 per cent) experienced a marginal decline in their yields under APCNF, Maize (11.34%) has experienced a notable decline during the Kharif 2019-20.

Table 3.4: Differences between the estimated yields under APCNF and Non-APCNF during Kharif 2019-20

In quintals per ha

Crop	Yields under APCNF	Yields under NON - APCNF	Changes in yields due to APCNF in qtls.	Changes in yields due to APCNF in %
Onion	213.25	195.01	18.24	9.35
Turmeric	125.32	114.24	11.08	9.70
Chillies*	49.78	45.68	4.10	8.98
Ragi	20.81	16.88	3.93	23.28
Paddy**	50.87	48.06	2.81	5.85
Blackgram*	12.62	10.24	2.38	23.24
Jowar	20.15	18.25	1.90	10.41
Red gram	6.47	6.09	0.38	6.24
Bengal gram	15.57	15.31	0.26	1.70
Groundnut	16.53	16.38	0.15	0.94
Cotton	18.95	19.52	-0.57	-2.92
Maize	49.96	56.35	-6.39	-11.34
Sugarcane	778.02	786.84	-8.82	-1.12

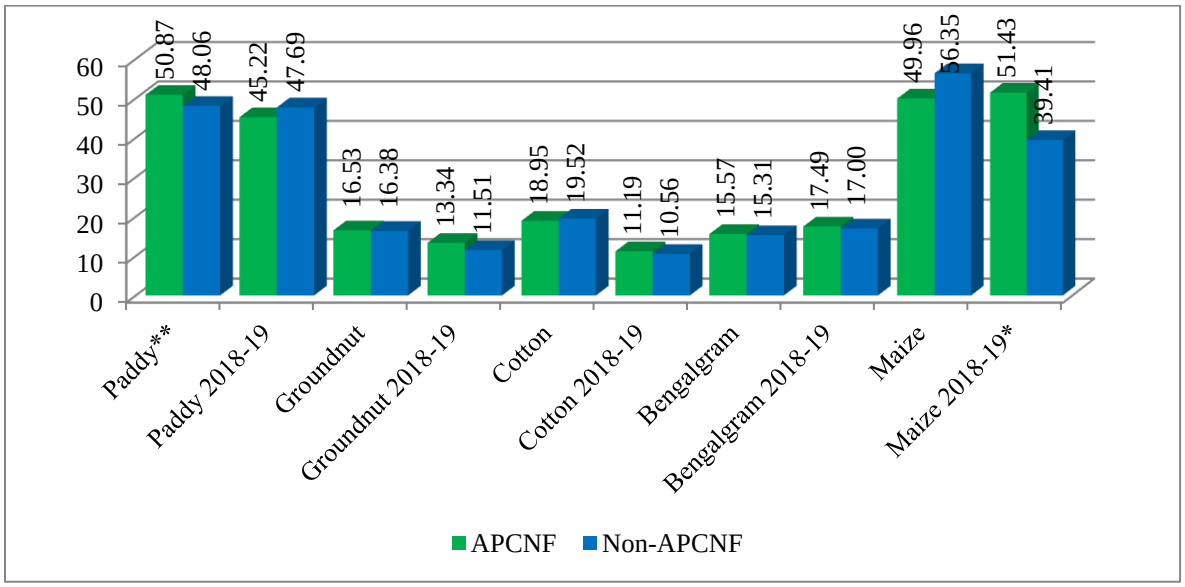
Source: *Field Survey* ***Note:*** ** Significant at 1 per cent level of significance*

As the yields are crucial for the APCNF project, at least at this point of time, the changes in the crop yields at the district, irrigation and rainfed conditions are analysed here. In the Kharif 2018-19 and 2019-20 surveys, there are five common crops. First, the yield obtained this year Kharif are compared with the last year Kharif yields. The yields obtained under APCNF and non-APCNF conditions during last two years are shown at Figure 3.5. One point

to note is that the observed larger variations in the yields of Groundnut and Cotton during 2018-19 and 2019-20 may be due to variation in time periods of data collection. While in 2018-19, data was collected up to December 2018, in 2019-20 data has been collected up to February 2020; covering late Kharif and early Rabi sown fields also. However, these variations in the time of data collection do not affect the major objective of the study, i.e. comparing the yields of APCNF and non-APCNF at any given point of time. Major positive change experienced during 2019-20 is a significant increase in Paddy yield to 50.87 quintals per ha from 45.22 quintals in 2018-19. Last year the Paddy yield under APCNF was less than that of non-APCNF. On the other hand, lesser yield of Maize under APCNF compare to non-APCNF conditions is a negative development during this season. Last year, Maize under APCNF has recorded higher yields compare to non-APCNF in both seasons. This year, the consolation is that difference between APCNF and non-APCNF yields is not statistically significant. ***Another important inference, which can be drawn from Maize data, is that APCNF reduces significantly the annual fluctuations in the crop yields. The variation between the APCNF yields of 2018-19 and 2019-20 is -2.86%; the same, under non-APCNF, is 42.98%.*** The marginal gap in the yields of Groundnut under APCNF and non-APCNF yields needs a closer look by the RySS. Groundnut is, usually, cultivated on the most degraded soils and in harsh climatic conditions. The microorganism, introduced under APCNF, may need additional protection and other measures to survive and function effectively in those conditions.

Figure 3.5: Yields of select crops under APCNF and Non-APCNF during 2018-19 & 2019-20

In quintals per ha

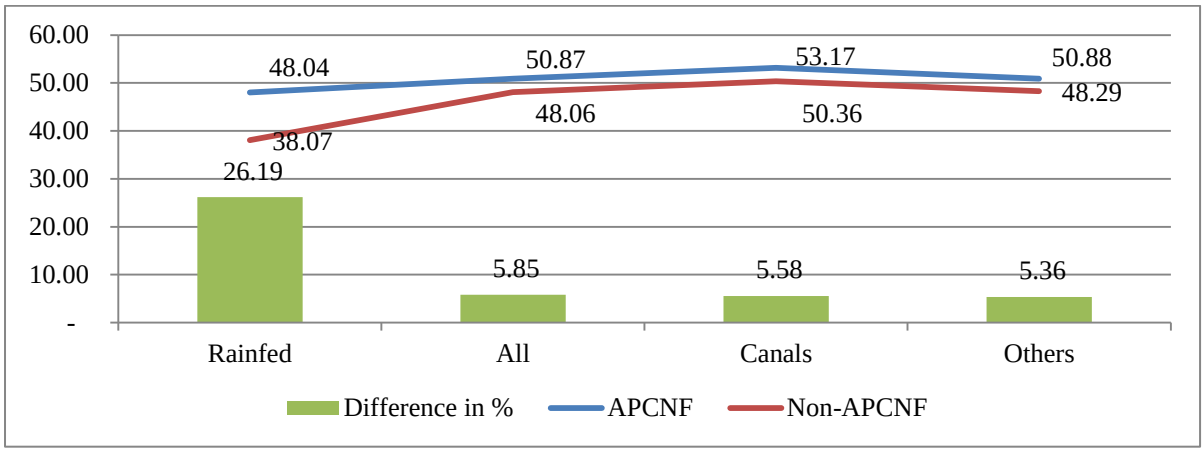


Sources: Field Surveys, 2018-19 and 2019-20

Changes in the Paddy yield under different irrigation conditions are shown at Figure 3.6. Irrigation modes considered in this study are (1) canal irrigation, (2) other sources (include bore-well, tanks, open wells, streams, lift irrigation), and (3) rainfed (no irrigation). Highest increase of 26.16 per cent in Paddy yields is obtained under rainfed conditions. It is validating the assumption that APCNF needs much less water/ soil moisture compared to conventional agriculture (non-APCNF). There are small differences in the variation in the Paddy yields under canal irrigation (5.58%) and other sources of irrigations (5.36%).

Figure 3.6: Changes in Paddy yields due to APCNF under different irrigation modes

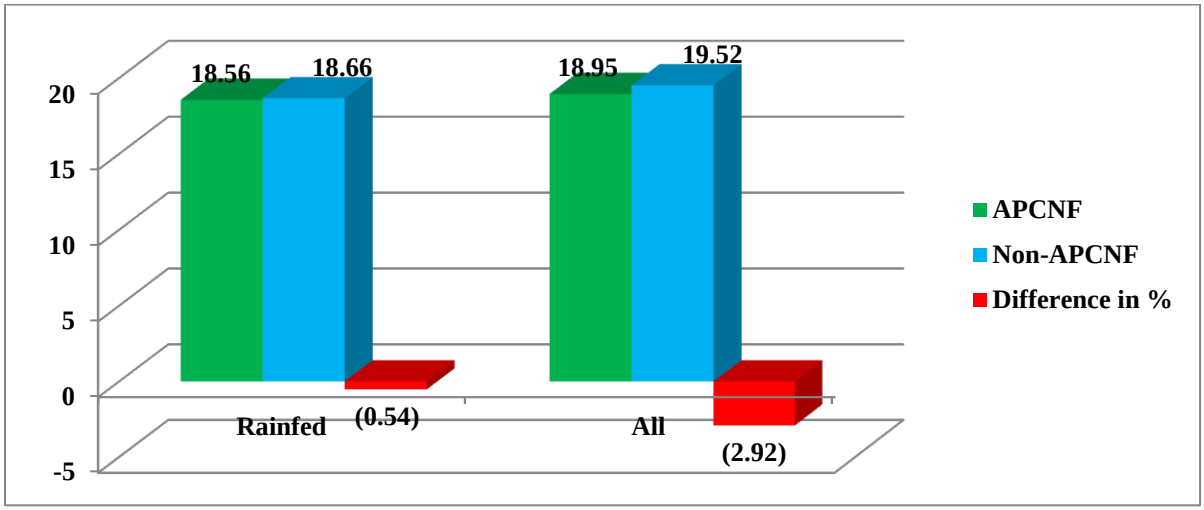
In quintals per ha



Sources: Field Survey, 2019-20

Cotton being a predominantly rainfed crop, bulk of the cotton sample come from rainfed conditions. A comparative picture of the cotton yields under rainfed condition and all irrigation conditions, including rainfed condition, are shown at Figure 3.7. The difference between APCNF and non-APCNF cotton yields among all the samples is -2.97%, i.e. the Cotton yields under APCNF cultivation is less. The same is just 0.54% under the rainfed conditions. It implies that the APCNF's Cotton yield must be quite less than that of non-APCNF. It has once again proved that the APCNF needs less water or soil moisture.

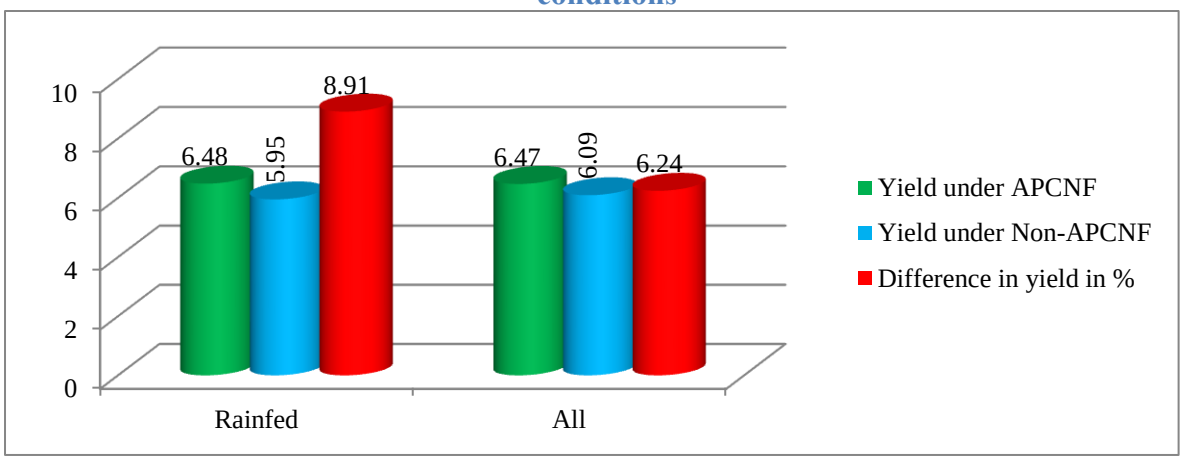
Figure 3.7: Variations in Cotton yields, due to APCNF, under rainfed and all conditions



Sources: Field Survey, 2019-20

Red gram also being a rainfed crop, most of the sample came from the rainfed areas. However, a few samples are from irrigated areas. The variation in APCNF and non-APCNF yields under rainfed conditions and all conditions are presented at Figure 3.8. While the yields of APCNF under rainfed and all conditions are almost same, the non-APCNF yields are marginally less under rainfed conditions. The gap between APCNF and non-APCNF is large under rainfed conditions (8.91%), compare to all conditions (6.24%). It implies that the gap would be even close under the irrigated conditions. Once again it proves that APCNF is more effective under the rainfed conditions.

Figure 3.8: Variations in Red gram yields, due to APCNF, under rainfed and all conditions

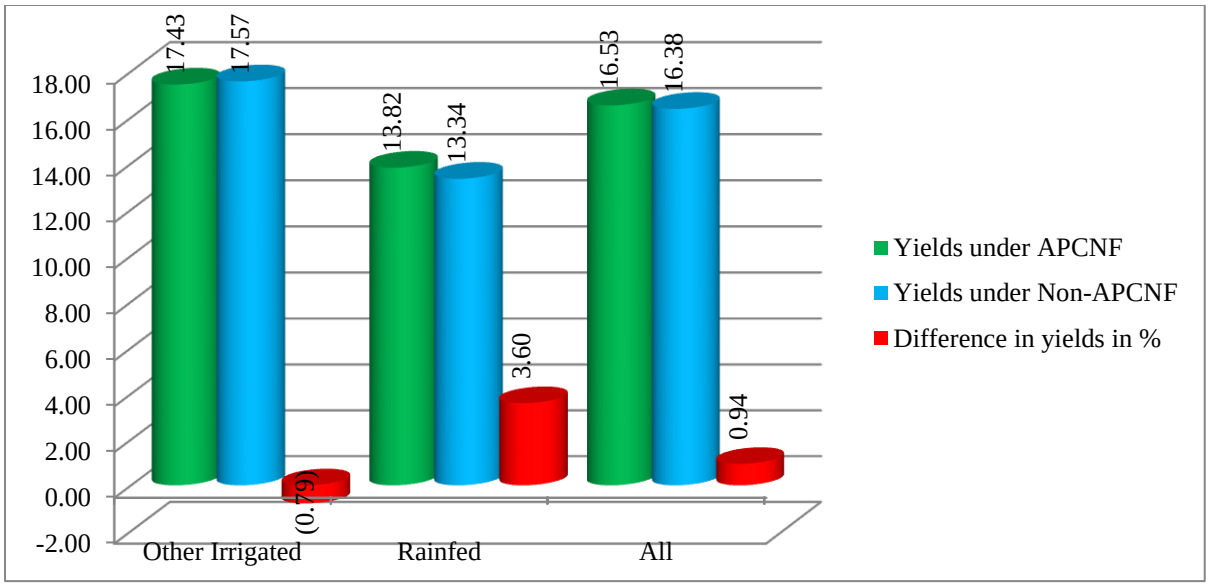


Sources: Field Survey, 2019-20

Groundnut crop also has good number of samples. The sample sizes allow the comparison of the APCNF and non-APCNF yields under rainfed condition, other irrigation conditions and

all sources, including the rainfed. The irrigation status wise the yield differences are presented at Figure 3.9. The APCF yields are less than non-APCNF yields under other irrigation conditions by 0.79%. The APCNF yields are more than that of non-APCNF by 3.60%. As mentioned above that Groundnut is being cultivated on the most degraded soils and harsh conditions in Anantapuramu and other Rayalaseema districts, mostly under the rainfed conditions. Microorganism may not survive and function effectively under those harsh environment and degraded soils. Special efforts may be needed in those conditions and soils. Promoting the tree-based farming may be one good possible solution for those soils and conditions.

Figure 3.9: Variations in Groundnut yields, due to APCNF, under different irrigation conditions

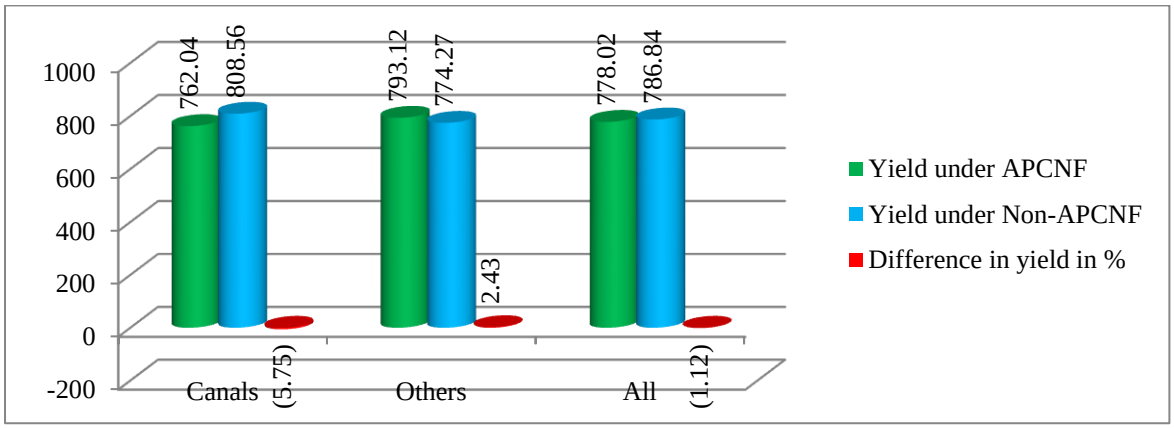


Sources: Field Survey, 2019-20

Sugarcane too has enough samples to undertake the sub-crop analysis. It is completely irrigated crop. Hence the sub-crop analysis is carried out under canal irrigation and other sources of irrigation conditions. The yield variations are shown at Figure 3.10. The APCNF yields under canal irrigation (762.04 quintals per ha) are less than the non-APCNF yields (805.56 quintals per ha) by 5.75%. Under other sources of irrigation, the Sugarcane yields (793.12 quintals per ha) under APCNF are higher than that of non-APCNF (774.27 quintals per ha) by 2.43 per cent. It appears that microorganism is less effective under canal irrigation, which is heavy, gets flooded and less controlled. Previously Paddy also yielded lesser yields under canal irrigation. RySS may focus on this issue. Recent experiments in the delta and north costal districts by the NGOs indicate that the System of Root Intensification (SRI), also known as the System of Rice Intensification, method has yielded very high yields in

Sugarcane. RySS may explore this method in canal irrigated areas in particular, and in all areas in general.

Figure 3.10: Variations in APCNF and Non-APCNF Sugarcane yields under different irrigation conditions

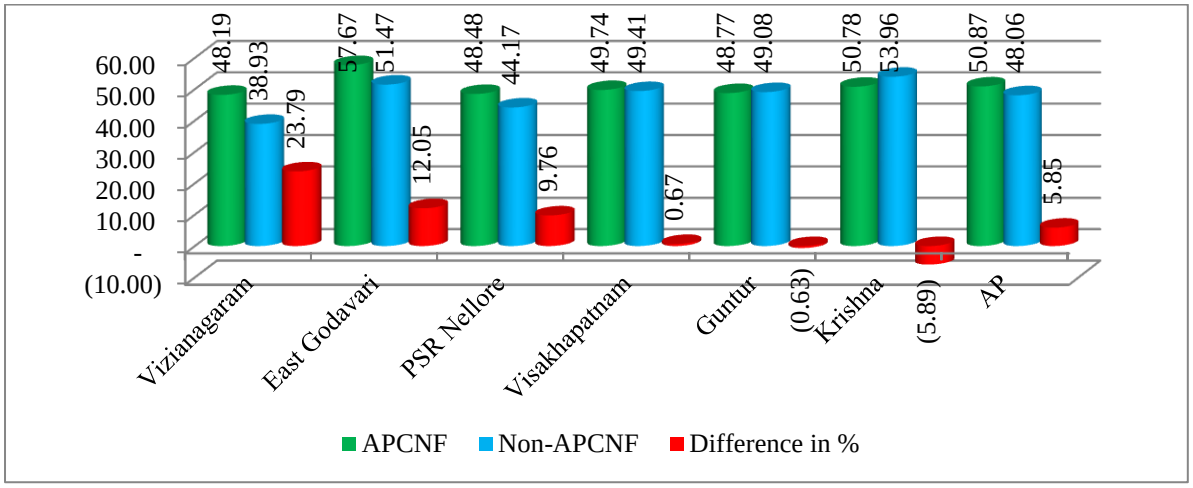


Sources: Field Survey, 2019-20

Irrigation type, including rainfed, wise analysis of the five crops indicates the APCNF need less water and soils moisture. However, APCNF appeared to be less effective under canal/ flood irrigation and degraded soils and harsh environments. To overcome these challenges, RySS may explore the possibility of introducing the SRI in the canal irrigation area and BAIF's tree-based cropping model in the poor and completely degraded soils and harsh environment, along with APCNF.

The performance of these five crops across the select district is analysed below. The variations in Paddy yields, due to APCNF, across select district are presented at Figure 3.11. The highest Paddy yields under APCNF is achieved in East Godavari (57.67 quintals per ha) district followed by Krishna (50.78 quintals per ha). Lowest yields 48.19 quintals per ha are recorded in Vizianagaram district. Under non-APCNF cultivation, the highest Paddy yields 53.96 quintals per ha are recorded in Krishna followed by East Godavari (51.47 quintals per ha). The least yields 38.93 quintals per ha, under non-APCNF, are recorded in Vizianagaram preceded by PSR Nellore (44.17 quintals per ha). Out of six districts considered here, in four districts the Paddy yields under APCNF are higher and in two districts less than non-APCNF. The highest increase in the Paddy yields, due to APCNF, are realised in Vizianagaram (23.79%), and followed by East Godavari (12.05%) and PSR Nellore (9.76%). While there is a marginal decline in the Paddy yields, due to APCNF, in Guntur (-0.63%), it is visible in Krishna (5.89%).

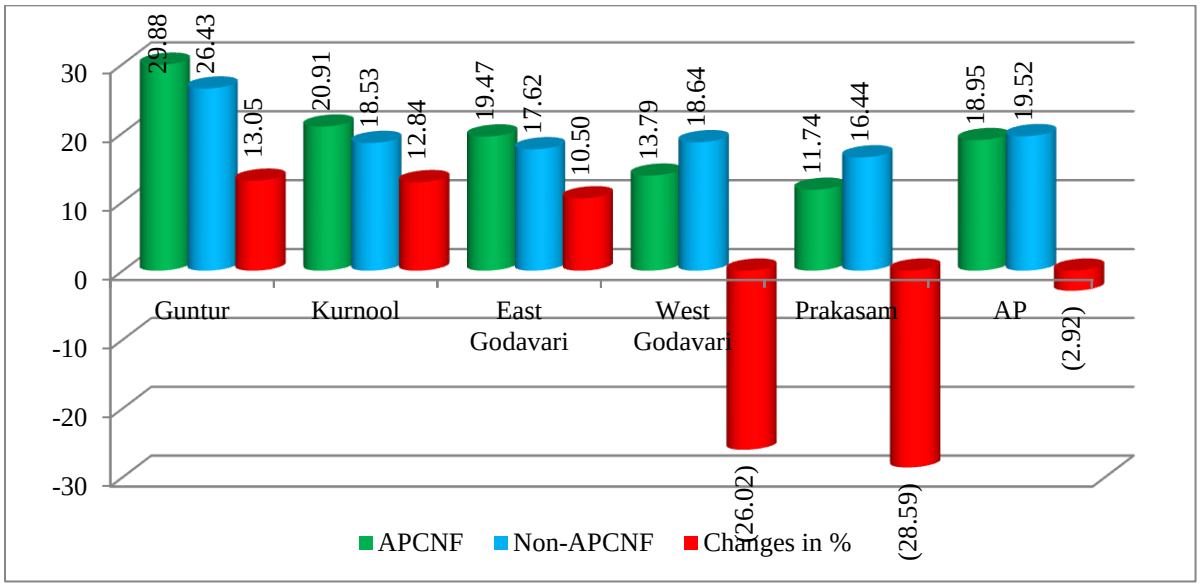
Figure 3.11: Variations in Paddy yields, due to APCNF, across the select districts



Sources: Field Survey, 2019-20

The variations in the Cotton yields, due to APCNF, are presented at Figure 3.12. Wide fluctuations in the Cotton yields are a well-known fact. Cotton is known as one of major distressing factors for the farmers in the country and one of the major contributory factors for farmers' suicides. There are wide variations in the Cotton yields, under APCNF, across the select district. It varies from 11.74 quintals per ha in Prakasam district to 29.88 quintals per ha in Guntur district. There are relatively lesser variations across the districts in the Cotton yields under non-APCNF; leading to wider fluctuation in the changes due to APCNF. Out of five districts considered in this analysis, three districts recorded more than 10% increase in yield and two districts experienced more than 26% decline due to APCNF. The highest increase in Cotton yields due to APCNF is in Guntur districts (13.05%), followed by Kurnool (12.84%) and East Godavari (10.50%). The largest decline in Cotton yields, due to APCNF, is reported in Prakasam district (28,59%) followed by by West Godavari (26.02%). The district wise analysis makes it clear that a decline experienced in the Cotton yield in the state is due to the local and temporary factors in the Prakasam and West Godavari districts. These factors may give a wonderful opportunity to RySS to study and improve.

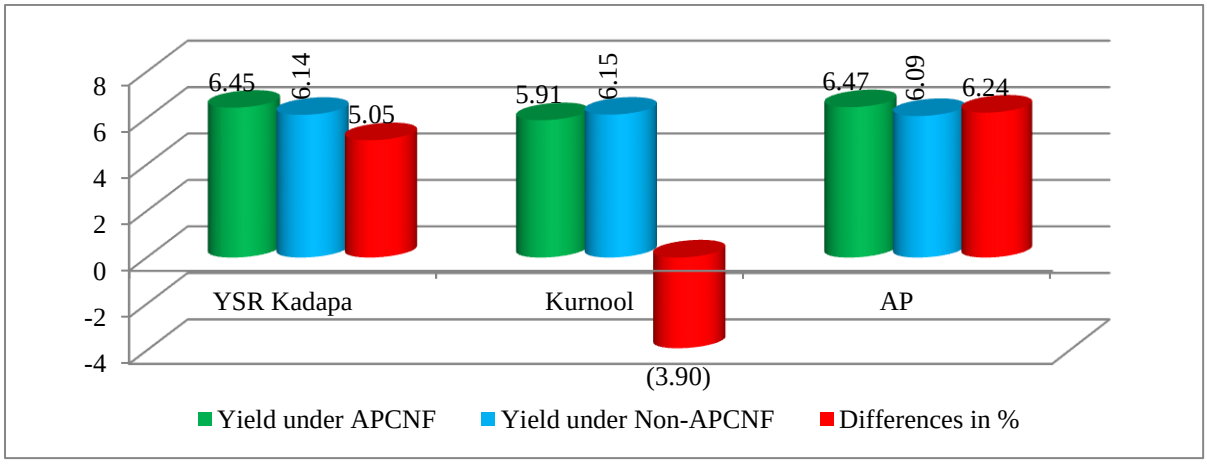
Figure 3.12: Variations in Cotton yields due to APCNF across select districts



Sources: Field Survey, 2019-20

The changes in Red gram yields, due to APCNF, across select districts are presented at Figure 3.13. Out of two districts considered here, the Red gram yields have increased in YSR Kadapa by 5.05% and declined in Kurnool by 3.90%, due to APCNF. Relatively larger increase in the state indicates that in other districts the Red gram yields have increased. .

Figure 3.13: Changes in Red gram yields, due to APCNF, in select districts



Sources: Field Survey, 2019-20

Groundnut analysis at district level (Anantapuramu district only),once again confirmed the proposition that the microorganism may be ineffective in the degraded soils and harsh environment. Anantapuramu has the most degraded soils and harsh environment in the state.

Sugarcane sample distribution allowed the district level estimates only in Visakhapatnam district. The gap between the Sugarcane yields of APCNF and non-APCNF is 0.83% in Visakhapatnam compared to -1.12% in the state. As mentioned elsewhere in the report that propagation of SRI method in Sugarcane cultivation in the costal districts may be one of the reasons for higher production of the crop under non-APCNF conditions. RySS may incorporate the method in canal irrigated crops and regions, to start with.

3.5. Gross returns

Gross returns from the crop cultivation are defined as the sum of the values of the crop output and by-products. Using the prices of crop output and by-products reported by the sample farmers and crop outputs estimated through CCEs, crop wise gross returns are estimated. Normally, gross returns follow the patterns of the changes in the crop yields. However, APCNF crops/ outputs, being chemical free and healthy products, they command premium price in the market. Though RySS has not yet rolled out the marketing interventions, some farmers have developed some alternative marketing channels such as sale to relatives, friends, neighbours, etc. direct sale to urban consumers, institutions, malls, online, etc. Though only a few APCNF farmers are involved in the alternative marketing channels, they could influence the average prices realized for different crops. The prices will be discussed in chapter 5. This section compares the gross returns generated by the APCNF farmers, compared to non-APCNF farmers.

The crop wise gross returns per ha are shown at Table 3.5. Out of 13 crops analysed, the gross returns per ha, under APCNF are higher than that of non-APCNF in 11 crops. The gross returns per ha, under APCNF, vary from ₹37,630 in Red gram to ₹7,91,139 in Turmeric. The gross returns per ha, under non-APCNF, vary from ₹31,452 in Red gram to ₹7,17,538 in Turmeric.In absolute terms, the gross returns have increased from ₹5,954 per ha in Jowar to ₹1,19,149 per ha in Onion. During the survey period, the Onion price in the market has increased substantially, which resulted in higher gross returns. Out of total 13 sample crops, the gross returns have increased, due to APCNF, in the range of ₹65,000 to ₹1,20,000 in three crops; from ₹10,700 to 17,500 in four crops; from ₹5,000 to ₹8,500 in four crops. The same has declined in the range of ₹2,700 to ₹11,700 in three crops.

In terms of rate of change, the highest increase in gross returns, due to APCNF, is 25.21% in Black gram, followed by Onion (24.67%), Red gram (19.64%) and Ragi (18.08%). The least increase in the gross returns, due to APCNF, is 5.53% in Groundnut. In the two crops, viz. Cotton and Maize, the gross returns, under APCNF, are less than that of non-APCNF by 3.11% and 10.97% respectively.

Table 3.5: Crop wise changes in gross returns under APCNF and Non-APCNF (₹/ha)

Crop	Gross returns under APCNF	Gross returns under Non-APCNF	Change due to APCNF in ₹	Change due to APCNF in %
Onion	6,02,131	4,82,982	1,19,149	24.67
Turmeric	7,91,139	7,17,538	73,601	10.26
Chillies	6,24,899	5,59,099	65,801	11.77
Sugarcane	2,27,782	2,10,269	17,512	8.33
Black gram	85,785	68,514	17,270	25.21
Ragi	82,191	69,607	12,584	18.08
Paddy	92,161	81,460	10,701	13.14
Bengal gram	70,453	61,948	8,505	13.73
Red gram	37,630	31,452	6,178	19.64
Jowar	58,753	52,799	5,954	11.28
Groundnut	98.236	93.091	5,145	5.53
Cotton	83,965	86,663	-2,698	-3.11
Maize	94,976	1,06,673	-11,697	-10.97

Sources: Field Survey, 2019-20

As mentioned above, gross returns depend on crop output and prices. Prices, in turn, depend on local conditions such as level of output, local demand, proximity to markets, urban areas, marketing infrastructure, etc., and more importantly on the quality of crop output. Prices do not depend on the production condition such as irrigation. However, organic, and natural farming can influence the prices significantly. The district wise gross returns in Paddy is analysed below. District wise gross returns from Paddy are presented at Table 3.6. The gross returns from Paddy, under APCNF, vary from ₹76,200 per ha in Visakhapatnam to ₹1,38,305 per ha in Chittoor. At the same time, the gross returns, under non-APCNF, vary from ₹56,577 per ha in Srikakulam to ₹1,74,696 per ha in Chittoor. The most surprising result is that Chittoor district, which achieved the highest gross returns from Paddy, under APCNF, recorded 21% lower gross return than thatof non-APCNF. Out of total 13 district, in nine districts, the gross returns from Paddy, under APCNF, are higher than that of non-APCNF. In these nine districts, the gross returns vary from ₹1,394 per ha in Visakhapatnam to ₹36,886 per ha in East Godavari. In four districts, where the gross returns, from Paddy under APCNF,

are less than that of non-APCNF, the gross returns vary from -2,613 in Krishna to -20.83% in Chittoor. In terms of rate of change, the gross returns vary from -20.83% in Chittoor to 54.79% in West Godavari. The changes in gross returns are over 40% in four districts, over 26% in one district and in the range of 11% to 20% in three districts.

Table 3.6: District wise gross returns from Paddy under APCNF and non-APCNF and changes (₹/ha)

District	APCNF	Non-ACNF	Change in Rs	Change in %
West Godavari	92,006	59,440	32,566	54.79
Srikakulam	80,754	56,577	24,177	42.73
East Godavari	1,25,900	89,014	36,886	41.44
Vizianagaram	91,665	64,968	26,698	41.09
Anantapuramu	1,11,183	87,836	23,347	26.58
Guntur	97,262	81,414	15,849	19.47
PSR Nellore	82,369	72,746	9,623	13.23
YSR Kadapa	1,10,239	98,739	11,500	11.65
Visakhapatnam	76,200	74,806	1,394	1.86
Krishna	92,065	94,679	-2,613	-2.76
Prakasam	1,01,394	1,07,919	-6,525	-6.05
Kurnool	84,625	91,418	-6,792	-7.43
Chittoor	1,38,305	1,74,696	-36,391	-20.83

Sources: Field Survey, 2019-20

3.6. Net returns

It is quite interesting to know the impact of the APCNF on net returns from cultivation, the all-important indicator. The changes in the expenditure on PNPIs, paid out cost of cultivation, yields, gross returns (output prices) per hectare under APCNF vis-a-visnon-APCNF should result in the net additional returns under the APCNF across all crops. **The net returns of a crop are obtained by subtracting of total paid out costs of cultivation of that crop from grass returns (value of crop output and by-products) of that crop**. The paid-out cost of rent on leased in lands were not considered for the sake of uniformity. The cost of own labour is also not included in the total costs. (The issue of own labour would be discussed in the Chapter 5). Crop wise changes in net returns due to APCNF during Kharif 2019-20 are given at Table 3.7. During the Kharif season, highest net returns under APCNF, ₹6,54,361 is obtained in Turmeric, and the lowest amount of net return is ₹19,466 in Red gram. The net returns, under Non-APCNF, vary between ₹4,219 in Red gram and ₹5,18,516 in Turmeric. Out of 13 sample crops, the net returns under APCNF are higher than that of Non-APCNF, in 12 crops; the exception is Maize. The highest additional net returns of ₹1,61,398 per ha are

realised in Onion, followed by ₹1,35,844 per ha in Turmeric, and ₹1,27,121 per ha in Chillies. The lowest additional returns of ₹-3,291 per ha is realized in Maize, preceded by ₹4,837 per ha in Sugarcane, and ₹6,435 per ha in Jowar. Out of 13 sample crops, in three, the net returns are more than ₹1.27 lakh per ha, due to APCNF; in five crops the additional net returns are in the range of ₹20,000 to ₹25,000 per ha. ***In terms of rate of change, the results appear to be unbelievable. It is the result of the combined effect of reduction in the paid-out cost of cultivation, increase in yields and realization of higher prices.*** The rates of change/ increase in net returns, due to APCNF, are in the range of 165% to 361%, in three crops. The same is in the range of 24% to 67% in eight crops. In the remaining two crops, a small increase of 4.37% is obtained in Sugarcane and some small decline is experienced in Maize (-5.26%). ***It may be worth noting that in Sugarcane, despite a small decline in the yield and an increase of 12.72% in total paid out costs, the net returns have increased by 4.37%; due to higher price realization. It once again confirms the hypothesis that APCNF improve the quality of crops and potential to realize higher prices.***

Table 3.7: Variations in crop-wise net returns under APCNF and Non-APCNF

₹/ha

Crop	Net returns under APCNF	Net returns under Non-APCNF	Changes due to APCNF in ₹	Changes due to APCNF in %
Onion	5,36,254	3,74,857	1,61,398	43.06
Turmeric	6,54,361	5,18,516	1,35,844	26.20
Chillies	4,48,307	3,21,187	1,27,121	39.58
Bengal gram	38,257	13,571	24,686	181.90
Black gram	59,749	35,761	23,988	67.08
Cotton	37,520	14,124	23,396	165.65
Ragi	68,342	45,757	22,584	49.36
Paddy	51,426	31,031	20,395	65.73
Red gram	19,466	4,219	15,248	361.43
Groundnut	51,190	41,346	9,843	23.81
Jowar	33,810	27,375	6,435	23.51
Sugarcane	1,15,476	1,10,640	4,837	4.37
Maize	57,422	60,610	-3,188	-5.26

Sources: Field Survey, 2019-20

As production conditions also effects the net returns, the changes in the net returns in irrigation and rainfed conditions are analysed. Changes in net returns, due to APCNF, under irrigated and rainfed conditions are presented at Table 3.8. In the irrigated areas, the net returns, under APCNF, vary from ₹9,960 per ha in Red gram to ₹6,16,647 per ha in Turmeric.

The same under non-APCNF vary from ₹4,509 per ha in Red gram to ₹5,03,984 per ha in Turmeric. The changes in net returns, due to APCNF under irrigated conditions vary from ₹-6,194 per ha in Maize to ₹1,70,465 per ha in Onion. Out of 13 sample crops, three crops, viz. Onion, Chillies and Sugarcane, do not have rainfed sample. In the remaining 10 crops, the net returns, under APCNF in rainfed areas, vary from ₹19,886 per ha in Red gram to ₹7,37,929 per ha in Turmeric. The same, under non-APCNF, vary from ₹5,741 per ha in Red gram to ₹7,56,450 per ha in Turmeric. The changes in net returns, due to APCNF under rainfed conditions, vary from ₹-18,521 per ha in Turmeric to ₹39,012 per ha in Black gram. The crops in the Table 3.8 are arranged as per the APCNF sample size. By and large the non-APNCF sample size also followed the same pattern. The results on the top part of the table are more reliable and bottom part crops may be considered less reliable. In the first five crops, in terms of APCNF sample size, the increase in net returns, due to APCNF under rainfed conditions is higher than that of irrigated conditions in four crops; the only exception is Groundnut. As pointed out at more than one place, that Groundnut under rainfed conditions needs additional supplementary measures, for the APCNF to be effective.

Table 3.8: Changes in crop-wise net returns, due to APCNF, under irrigated and rainfed conditions

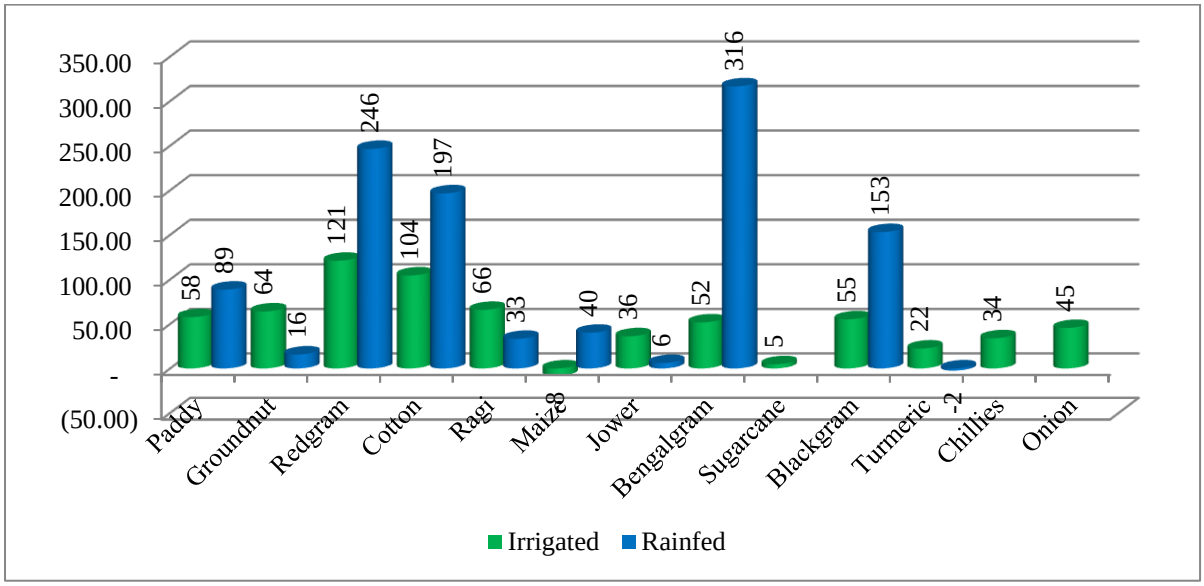
₹/ha

Crop	Irrigated areas			Rainfed areas		
	Net returns under APCNF	Net returns under Non-APCNF	Changes in net returns, due to APCNF in ₹	Net returns under APCNF	Net returns under Non-APCNF	Changes in net returns, due to APCNF in ₹
Paddy	53,311	33,827	19,484	50,140	26,592	23,547
Groundnut	52,936	32,274	20,662	39,247	33,938	5,310
Redgram	9,960	4,509	5,451	19,886	5,741	14,145
Cotton	39,040	19,097	19,944	41,163	13,882	27,281
Ragi	51,912	31,304	20,608	51,057	38,323	12,734
Maize	69,270	75,465	-6,194	62,713	44,772	17,942
Jower	33,964	24,949	9,015	36,853	34,744	2,109
Bengalgram	58,042	38,266	19,776	35,278	8,470	26,808
Sugarcane	1,15,787	1,10,640	5,148			
Blackgram	63,452	40,893	22,560	64,499	25,487	39,012
Turmeric	6,16,647	5,03,984	1,12,663	7,37,929	7,56,450	-18,521
Chillies	4,29,534	3,20,796	1,08,738			
Onion	5,45,322	3,74,857	1,70,465			
Max of above	**6,16,647**	**5,03,984**	**1,70,465**	**7,37,929**	**7,56,450**	**39,012**
Min of above	*9,960*	*4,509*	*-6,194*	*19,886*	*5,741*	*-18,521*

Sources: Field Survey, 2019-20 *Notes: Crops/rows area arranged per APCNF sample size*

The increase in net returns, due to APCNF under rainfed conditions is higher than that of irrigated conditions in major crops by substantial margin. The crop wise rates of changes in net returns, due to APCNF, under irrigation and rainfed conditions, are presented at Figure 3.14 below substantiates the trend. The trend once again confirms the supposition that APCNF is more effective under rainfed and irrigated dry cropping conditions. The only exception is Groundnut. The results of groundnut reconfirm the hypothesis that the microorganism may be less effective under much degraded soils and in harsh environments.

Figure 3.14: Changes in crop-wise net returns due to APCNF under Irrigated and Rainfed conditions



Sources: Field Survey, 2019-20 *Notes: Crops/rows area arranged per APCNF sample size*

District wise net returns obtained from Paddy cultivation, under APCNF and non-APCNF conditions, and changes in net returns due to APCNF are presented at Table 3.9. The net returns from Paddy, under APCNF, vary from ₹36,107 per ha in PSR Nellore to ₹87,722 per ha in Chittoor. The same, under non-APCNF, vary from ₹12,344 per ha in Srikakulam to ₹1,08,642 per ha in Chittoor. The net returns from Paddy, under APCNF, are higher than that of non-APCNF, in all, but one district-Chittoor. They vary from ₹-20,921 in Chittoor to ₹46,656 per ha in East Godavari. The net returns from Paddy have increased by more than 100%, due to APCNF, in seven out of total 13 districts. The same has increased by 54% in one district, and in the range of 19% to 33% in three districts. Kurnool recorded a modest increase. Chittoor district with over 19% decline in the net returns is the most surprising result. ***It is heartening to note that interior and relatively poorer district like Anantapuramu, YSR Kadapa, Srikakulam, and Vizianagaram have experienced more than 100% increase in net returns from Paddy, due to APCNF.*** One possible reason is that poorer

district may be under investing in the Paddy cultivation and/ or getting less yields, under conventional methods. Otherwise they might be getting premium prices for APCNF Paddy.

Table 3.9: District-wise changes in net returns from Paddy crop due to APCNF

₹/ha

District	Net returns under APCNF	Net returns under Non-APCNF	Changes, due to APCNF in ₹	Changes due to APCNF in %
East Godavari	78,883	32,226	46,656	144.78
Vizianagaram	58,097	21,458	36,639	170.75
YSR Kadapa	59,679	24,312	35,367	145.47
West Godavari	45,831	13,486	32,344	239.83
Anantapuramu	61,592	30,658	30,934	100.90
Srikakulam	38,351	12,344	26,008	210.69
Guntur	40,878	15,373	25,505	165.91
Visakhapatnam	52,254	33,902	18,352	54.13
Prakasam	58,950	46,388	12,562	27.08
Krishna	44,232	33,342	10,890	32.66
PSR Nellore	36,107	30,370	5,737	18.89
Kurnool	45,309	44,099	1,210	2.74
Chittoor	87,722	1,08,642	-20,921	-19.26
Max of above	87,722	1,08,642	46,656	240
Min of above	36,107	12,344	-20,921	-19

Sources: Field Survey, 2019-20

3.7. Model crops

Apart from introducing the biological inputs in place of chemical inputs, APCNF is also propagating the some model cropping patterns, including multi-tier crops of trees and seasonal crops, known as 5-layer and 7-layer models; integrated cropping, bund crops, boundary crops, inter-crops, pre-monsoon dry sowing (PMDS), kitchen gardens, etc. The purpose of these models is two-fold; (1) to protect the main crop from harsh environment and create conducive environment for higher yields, and (2) to obtain additional net income from same land throughout the year. More than 440 sample APCNF farmers have reported their experience in the model crops. The information is summarized at Table 3.10. The average benefit from model crops is ₹5,422 per farmer. The benefits vary from ₹4,076 from bund crop to ₹68,945 from integrated farming per farmer. As these interventions were initiated recently, many trees are too young to yield the expected benefits. In the coming years the economic and environmental benefits from some these models will increase manifolds; may surpass the economic benefits from the seasonal crops.

Table 3.10: Average per head benefits from model crops under APCNF (₹)

Sample in number and returns in ₹ per head

Crop	No. of sample	Net returns per farmer
5 layer model	19	7,989
7-layer model	4	14,827
Integrated farming	1	68,945
PMDS	24	11,431
Kitchen gardens	30	4,942
Bund crops	108	4,076
Border crops	257	4,899
Total	444	5,422

Sources: Field Survey, 2019-20

3.8. Conclusions

The biological inputs have resulted in significant reduction in the plant nutrients and plant protection expenditure in all, but one, crop during the season. Baring a few exceptions, the reduction in the expenditure on PNPIs is less under the rainfed conditions in most of the crops. It is obvious; as the farmers, under conventional methods of cultivation, invest less under the rainfed conditions; the scope for the reduction in the expenditure on PNPIs is less compared to that of irrigated conditions. The savings realized in total paid out costs is higher than the savings obtained in the expenditure on PNPIs in almost all crops. It is in contrast to the previous reports. It may be due to improvement of soil quality, which may reduce the need for mid-season operations such as ploughing, irrigation, etc. The expenditure on majority of agriculture inputs have declined in all sample crops, due to APCNF.

Though the crop yields decline in three crops, the gross and net returns have declined in one crop only. It implies that the decline in total paid out costs and higher realized prices have compensated the loss in yields in two crops. It also implies that the quality of APCNF output is better and fetching higher prices, albeit, in fewer cases.

The irrigation status wise and district wise analyses, broadly, indicate that APCNF is more effective under rainfed conditions and other irrigation conditions; benefitting the poorer and interior districts. The APCNF appeared to be less effective in Groundnut growing regions, especially in Anantapuramu, which has much degraded soils and harsh environment. In such conditions, RySS may consider the tree based farming. RySS may also consider incorporating SRI in the canal irrigated areas.

Chapter 4: Environmental, Health and Well-being Benefits

4.1. Introduction

Under APCNF, two major sets of intervention are being implemented in the state. The first set of interventions is the introduction of microorganisms into the soils to make the soils live, self-regenerating and productive. These measures include the culturing and application of microorganisms into the soils in the form of Beejamrutham, Ghanajeevamrutham, and Dravajeevamrutham.The second set of measures is aimed at protection and development/ multiplication of the microorganisms in the soil. The interventions include application of variety of Kashayams and Asthrams to protect the crops without harming the microorganisms in the soils; and intensive biomass oriented land use practices such as five layers cropping, inter cropping, mixed cropping, bund cropping, boundary cropping, PMDS, etc., to get higher and stable economic returns throughout the year; and keep the soils under cover throughout the year; and mulching and Whaapsa, so that the microorganisms can thrive and multiply. This chapter covers ecological and environmental changes witnessed and experienced in the APCNF fields and their impact. The expected impact includes the improvement in the soil quality, quality of output, capable of fetching higher/ premium prices, quality of food leading to less health issues and health related expenditure and increased wellbeing.

This chapter deals with the following three research questions:

i. What are the ecological and environmental improvements observed and experienced in the fields due to the APCNF interventions?
ii. What are the impacts of the APCNF on the health status of the farmers-families?
iii. What are the improvements observed in farmers' wellbeing due to APCNF?

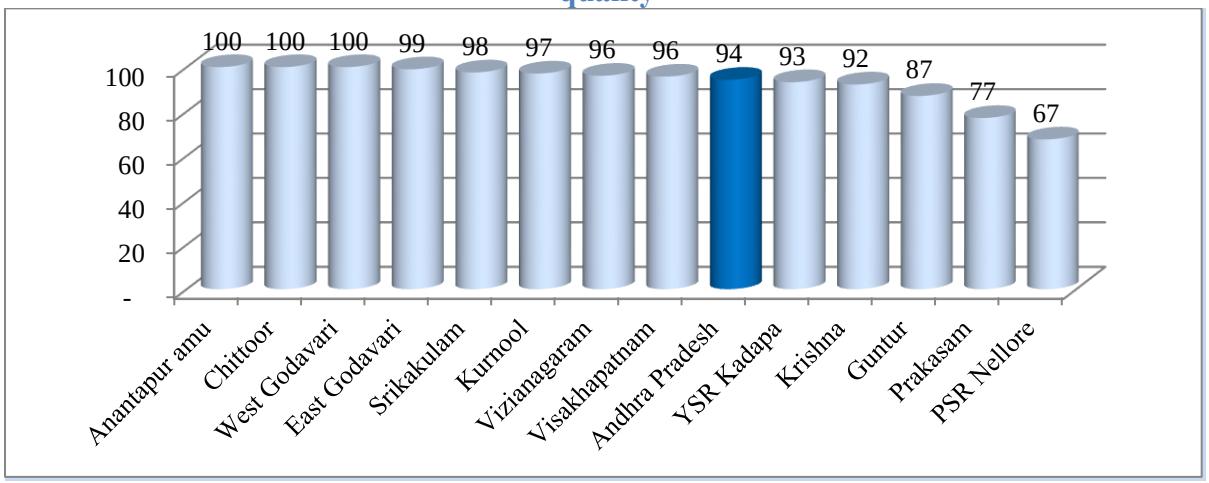
It may be noted that ecological and environmental changes need longer periods to show. As the APCNF program is just two to three years old in the sample villages, most of improvements, especially, the biological and chemical changes would be in the subtle or invisible form. It is very difficult to visualize and measure the full ecological and environmental impacts of the project interventions, at this stage. As the scientific testing of the soil quality, crop output quality, food quality, etc., are beyond the scope of the present

study, the farmers' perceptions and experiences are predominantly used in the analysis, in this chapter.

4.2. Improvements in soil quality

About 94% of APCNF sample farmers have reported that their soil quality has improved, due to APCNF. Out of total 13 districts, in as many as 10 districts, over 92% of farmers have experienced an improvement of the soils in their fields. In fact in three districts, viz. Anantapuramu, Chittoor and West Godavari, 100% farmers have stated that the quality of the soil has improved in their fields, due to APCNF (Figure 4.1). However, relatively fewer farmers in three south-coastal districts, viz. Guntur (87%), Prakasam (77%) and PSR Nellore (67%) experienced improvement of soils in their fields (Figure 4.1). Even the lowest figures are substantial and encouraging.

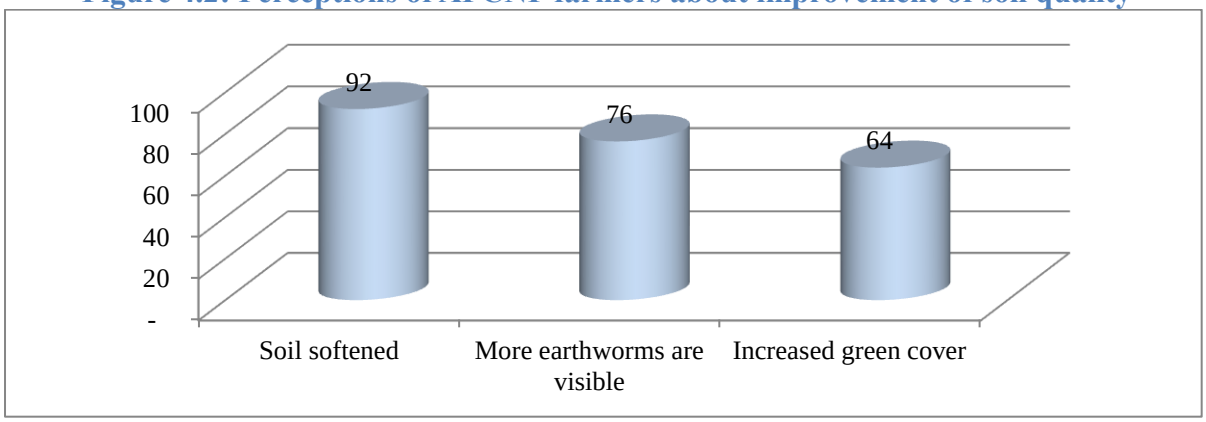
Figure 4.1: District-wise number of APCNF farmers reported the improvement in soil quality



Sources: Field Survey, 2019-20

Further, 92% of sample farmers have experienced a softening of soils in their fields; 76% are seeing more earthworms in the fields and 64% have observed an increased green cover in their fields (Figure 4.2). The possible reasons for relatively less number of farmers' perception and experience about increased green cover in their fields are – (1) low spread of 7-layer model, 5-layer model, 36X36-model, and other tree based models, and (2) too short period for trees to show their presence and impact.

Figure 4.2: Perceptions of APCNF farmers about improvement of soil quality



Sources: Field Survey, 2019-20

Farmers' perceptions are not just only evidence about the improvement in the soil quality due to APCNF. As discussed in the previous chapter that out of 13 sample crops, the yield have increased, due to APCNF, in10 crops, in the range of 0.94% to 23.28%; and the yields have declined from 1.12% to 11.34% in three crops. The yield levels achieved under APCNF, without applying, all important and crucial, agro-chemicals, are the testimony for the efficacy of the APCNF and soil improvement.

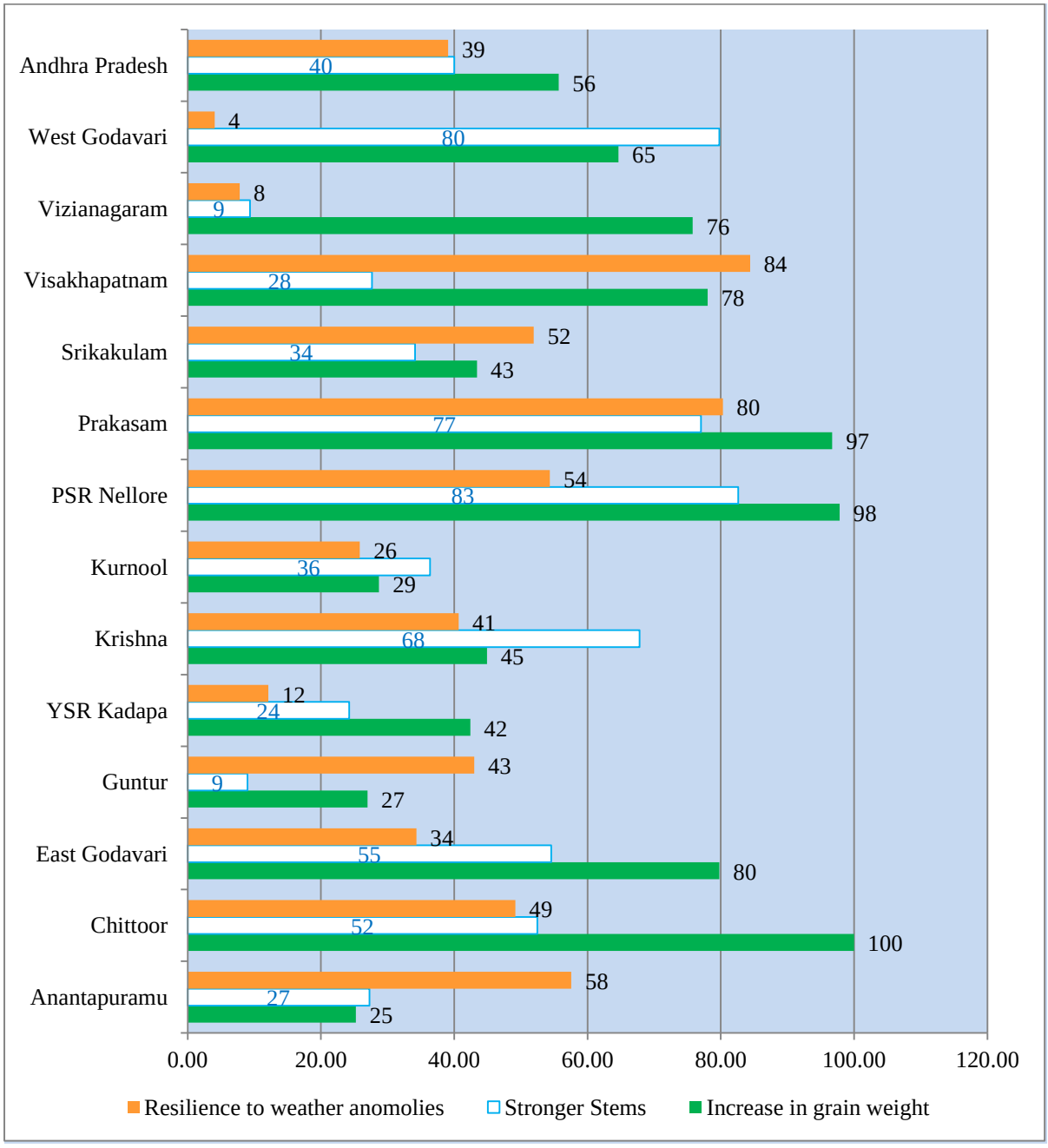
The APCNF farmers have reported that the quality of crop output has improved compared to conventional cultivation. The farmers, in FDGs and CSs, have recounted three dimensions of crop quality improvements, viz. size/ weight of grain, strength of stems and resilience to weather anomalies.Most of the APCNF sample farmers confirmed these. Precisely, at the state level, 56% sample farmer have said that the weight of the grain has increased; 40% sample farmers believe that crop stems become strong; and 39% mentioned that the crop resilience to weather anomalies has increased (Figure 4.3). However, there are wide variations across the districts in the farmers' perceptions about the quality improvement of the crops. While 100% farmers, in Chittoor, felt that the crop grain quality has increased, due to APCNF; only 25% farmers in Anantapuramu think that way. Only 9% farmers in Vizianagaram have sensed a stronger stem due to APCNF; but, as many as 83% farmers in PSR Nellore have witnessed the stronger stems under APCNF. Over 80% farmers in Visakhapatnam have stated that the crop resilience to weather anomalies has increased under APCNF; but, only 4% have confirmed this phenomenon in West Godavari.

However, one may wonder – whether the expected improvement in the quality of output of food items and by-products remain as the perceived benefits or realized in monetary and other tangible ways? The answer is a big yes. Though the RySS not yet rolled out the output

marketing interventions, some of the APCNF farmers are able to sell their produces at some premium prices through variety of marketing channels. Because of farmers own initiatives, the APCNF products got higher prices vis-à-vis Non-APCNF produces. This issue will be discussed in the next chapter. As mentioned above that higher yields obtained, under APCNF, in as many as 10 out of total 13 sample crops, also indicate, the qualitative improvements, such as increase in grain weight, stronger stems/ quality by-products, and crop resilience.

Figure 4.3: District-wise number of APCNF farmers reported qualitative improvements in their crops

in percentages

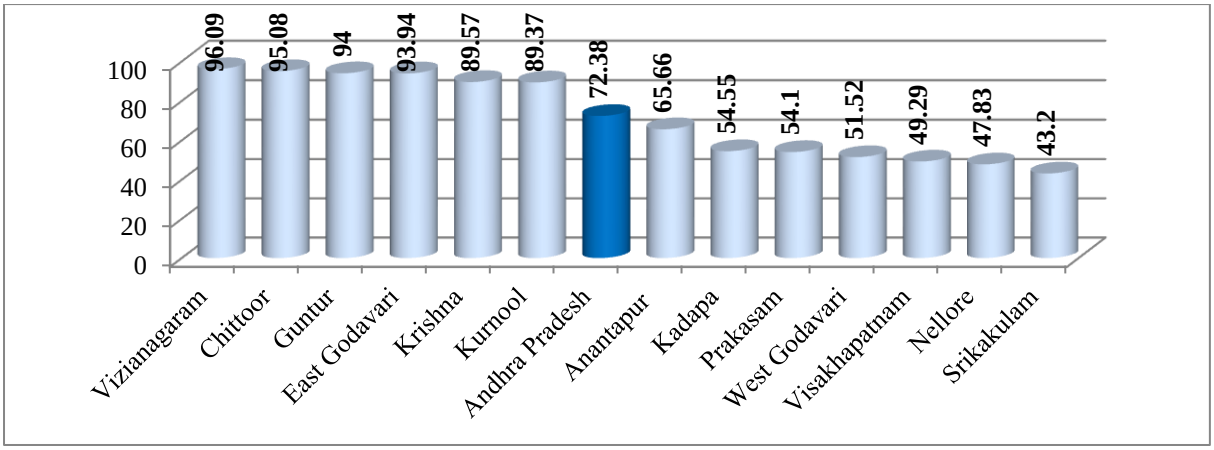


Sources: Field Survey, 2019-20

4.3. Health outcomes

Some of the dreaded consequences of the use of fertilizer and pesticide followed in the country are disastrous health risks to the farmers and contaminated food to the consumers, which leads to several health issues among the general public.[4]One of the expected benefits of the APCNF is complete elimination of health risks associated with the use of fertilizers and pesticides. There are clear and positive indicators for accomplishment of this goal. Over 72% APCNF farmers in the total sample, have reported that the health condition of their family members has increased due to APCNF. The same varies from 43.2% in Srikakulam to 96.09% in Vizianagaram (Figure 4.4).

Figure 4.4: District-wise Proportion of APCNF farmers reported improved health of the family members

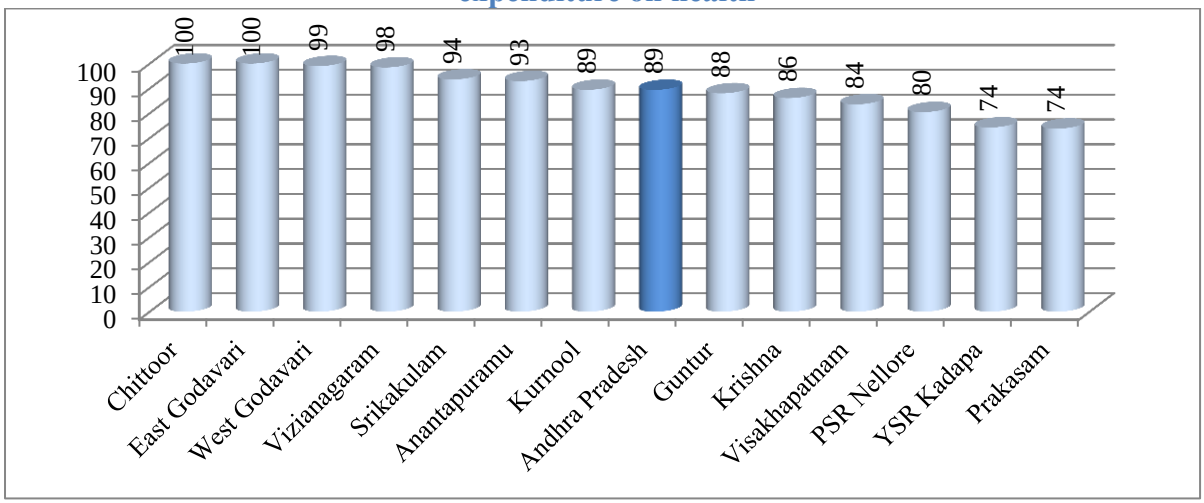


Sources: Field Survey, 2019-20

More encouraging trend is that nearly 90% sample farmers have experienced a reduction in their out of pocket expenditure on the health due to APCNF. It is widely experienced across the districts. While, minimum 74% sample farmers in Prakasam and YSR Kadapa have incurred less expenditure on health due to APCNF; 100% farmers in Chittoor and East Godavari have spent less on health during the study period, compared to earlier years.

[4] The health risks of the farmers are less discussed in the public for a. The article entitled "**The shocking tale of India's 'Cancer Train'"** in the Business Inside, on 10.06.2016, described how pesticide use in Panjab leading to the Cancer in the state. https://www.businessinsider.in/the-shocking-tale-of-indias-cancer-train/articleshow/52690219.cms.

Figure 4.5: District-wise number of APCNF farmers experienced a reduction in expenditure on health



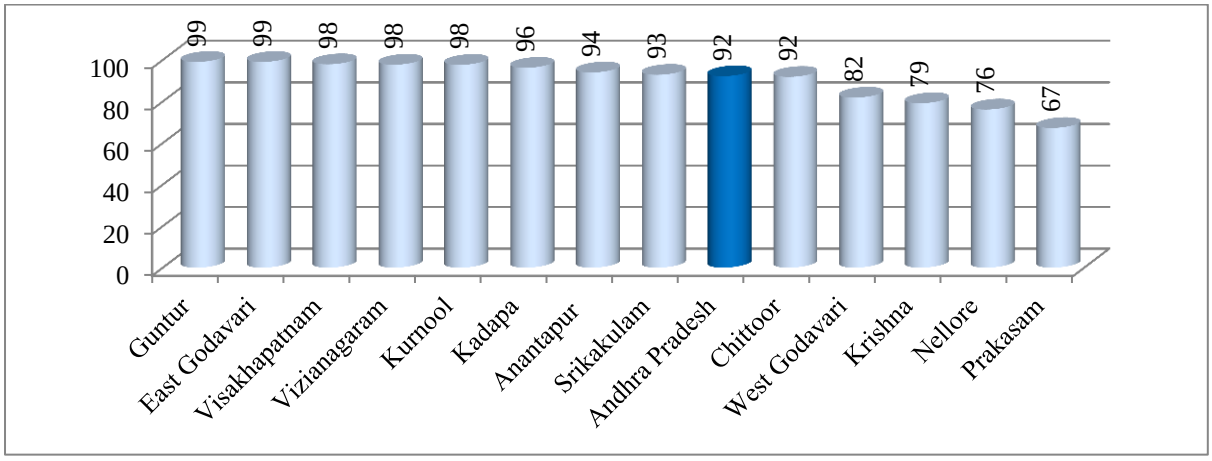
Sources: Field Survey. 2019-20

4.4. Farmers' wellbeing

These days, the farmers' welfare and wellbeing are gaining popularity. At all India level, the Government of India changed the name of the Ministry of Agriculture to the Ministry of Agriculture and Farmers Welfare. However, no significant changes in agriculture policies have been made to improve the welfare of the farmers. Various official reports point out a larger and growing aversion, among the farmers, towards agriculture. However, APCNF has been improving the farmers' perceptions towards agriculture and the overall wellbeing of the farmers. Farmers' wellbeing is broad term. Here, farmers' perceptions about their income, health, farming, and happiness have been analysed. The health issue is already covered in the previous section. In this section farmers' perception about agriculture, their income and happiness are covered.

Nowadays, there is growing awareness about the benefits of, and, growing demand for, the chemical free food, at least in the urban areas and among the middleclass and richer sections. The organic and chemical free food fetches premium prices. One of the principal objectives of the APCNF is to spread the awareness about the benefits of the chemical free food among the farmers and encourage them to consume the APCNF food. It is heartening to learn that about 92% of sample households are consuming the APCNF food. The same varies from 67% in Prakasam district to 99% in Guntur (Figure 4.6). It may be noted that consumption of APCNF food not only depends on the awareness, taste, and interest of the farmers; but also on the type of crops cultivated, traditions and cultures. It is possible that some of farmers, who are not consuming the APCNF food, may not be cultivating the food crops or food crops of their choice food.

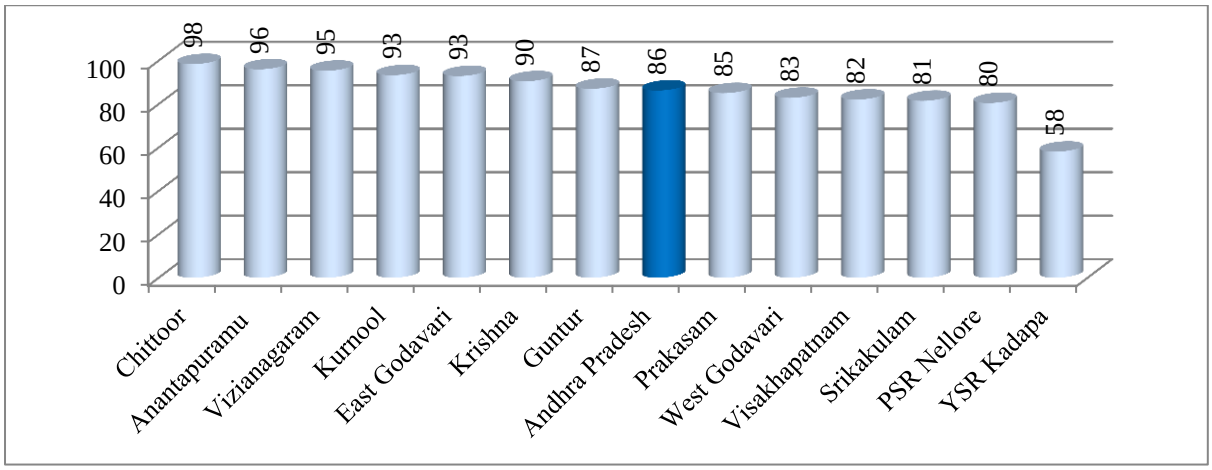
Figure 4.6: District-wise percentage of sample farmers consuming APCNF food



Sources: Field Survey, 2019-20

As APCNF crops are grown purely on cow dung and cow urine-based, inputs, there may be some apprehensions about the taste of the APCNF food. About 86% of sample farmers said that APCNF food is tasty. The same vary from 58% to 98% across the districts (Figure 4.7). It implies that overwhelming majority of sample farmers are enjoying the better taste of food.

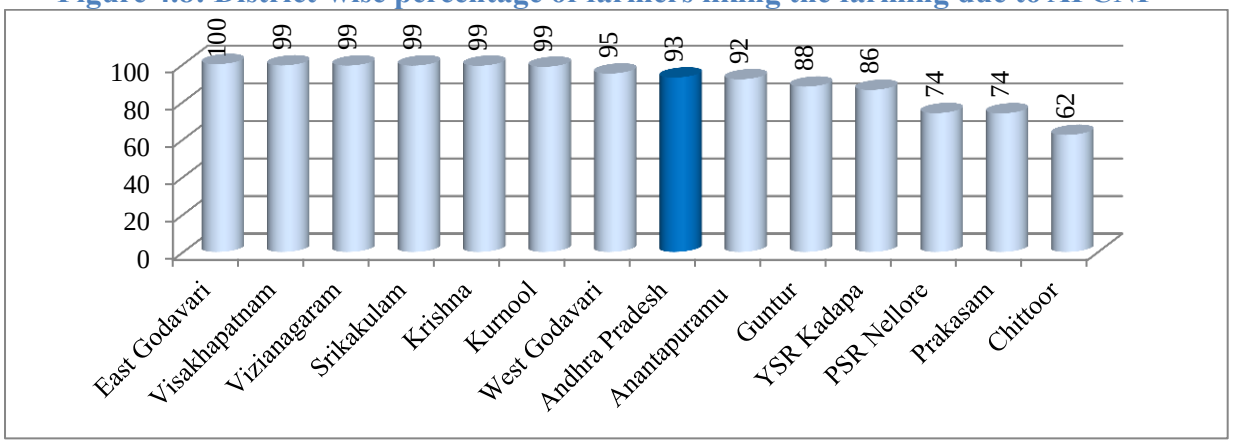
Figure 4.7: District-wise APCNF farmers reported APCNF food is tasty



As mentioned above, there was a large and growing aversion towards agriculture among the farmers, in general, in India. Major reasons were low or no profits and health issues. As APCNF has been resulting in increased profit margins and reduced health risks of using fertilizers and pesticides, and lower out of pocket expenditure, there is a growing interest in farming among the APCNF sample. About 93% APCNF sample farmers expressed their liking for agriculture due to APCNF. The same vary from 62% in Chittoor to 100% in East

Godavari (Figure 4.8). Further, almost 100% farmers in each district reported that they would like to continue the farming, after introduction of the APCNF.

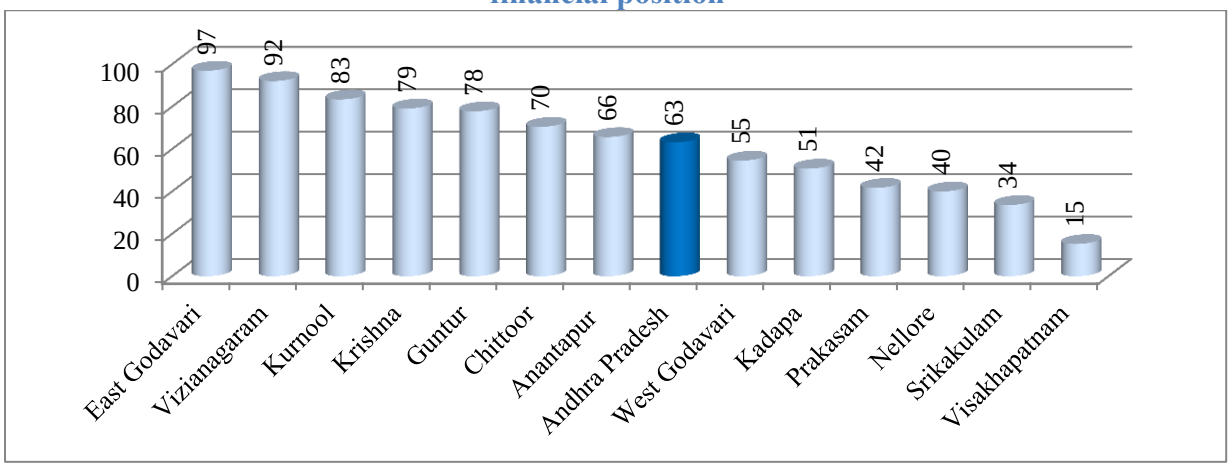
Figure 4.8: District-wise percentage of farmers liking the farming due to APCNF



Sources: Field Survey, 2019-20

In the previous Chapter, it was observed that the net returns have been substantially higher under APCNF, in 12 out of 13 sample crops. In most of the crops the revenue margin is quite high. Such increase would, naturally, result in improvement in the farmers financial positions. It is well known that farmers normally underreport their incomes and profits. Despite such strategic built-in bias, 63% of APCNF farmers have reported that their financial position has improved due to APCNF (Figure 4.9). Not surprisingly, there is wide variation among the districts with respect to the percentage of farmers' perceptions about the improvement of their families' financial position. About 97% of sample farmers in East Godavari have reported an improvement in their financial condition. The same is just 15% in Visakhapatnam.

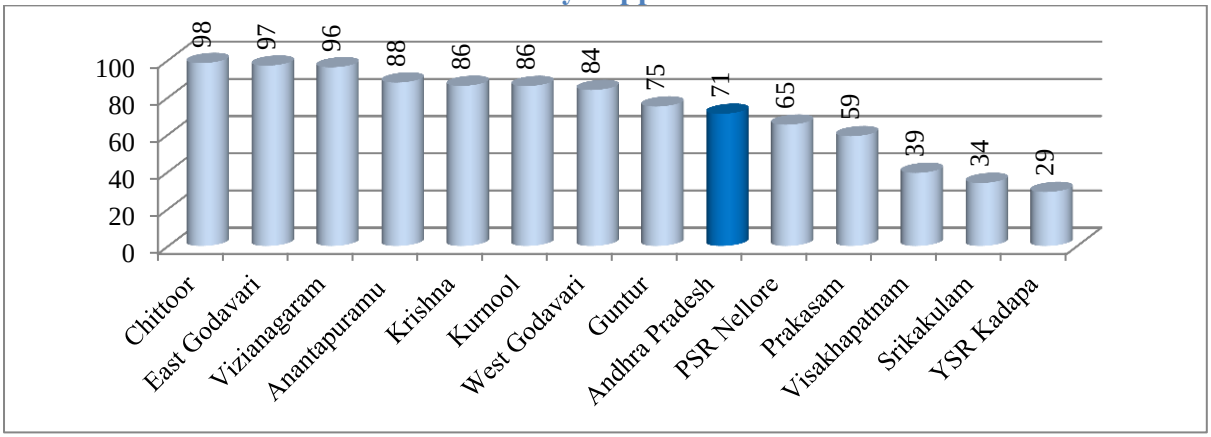
Figure 4.9: District-wise percentage of APCNF sample farmers reported the improved financial position



Sources: Field Survey, 2019-20

Recently, - Happiness Index is gaining popularity. Taking cue from the happiness index, the survey asked the APCNF farmers the question"Has happiness of your family improved due to lower stress with APCNF?" About 71% sample farmers have answered "yes" in the state. The same vary, across districts from 29% in YSR Kadapa to 98% in Chittoor. Out of total 13 districts, in eight districts, over 75% farmers have stated that the happiness of their families has increased due to APCNF (Figure 4.10). This is an encouraging sign.

Figure 4.10: District-wise number of APCNF farmers reported an increase in their family happiness



Sources: Field Survey, 2019-20

4.5. Conclusions

Overwhelming majority of the farmers have reported that the quality of the soils and crops have improved due to APCNF. The increase in yields in almost all crops and higher gross and net returns realized by the farmers presents solid evidence of the farmers' acceptance of natural farming. .

Again, overwhelming majority of the farmers is consuming the APCNF natural food, and have experienced an improvement in the health status of their family members and a reduction in their expenditure on health. Further, majority of members reported improvement in their financial position; their outlook towards agriculture; and their happiness, due to APCNF. These are delightful signs. However, there are wider variations across the districts in the perceptions of the farmers about benefits of the APCNF. These wider variations, across the districts, need further investigation.

Chapter 5: Realised and Potential Macro Benefits of APCNF

5.1. Introduction

This chapter covers the macro issues such as trends in employment generation, new marketing channels, prices realized, and actual benefits generated by the APCNF at the project level, in terms agri-chemicals saved/ avoided, crop output, and profits. . This chapter also covers an analysis of potential yield benefits and net returns based on the achievements of the top ten APCNF farmers. It also covers analysis of state level benefits, had the entire area cropped had been put under APCNF. Precisely the chapter deals with the following issues.

1. Project level benefits generated in terms of savings made in the expenditure on agri-chemicals.
2. Potential benefit, had the entire cropped area been put under APCNF.
3. New market channels developed, and prices realized in those channels.
4. Additional employment generated in agriculture due to APCNF.
5. Potential yields achieved so far.

Apart from the field data, the information available with RySS and macro data from Directorate of Economics and Statistics (DES), Government of AP are also used in this chapter.

5.2. Project level benefits

In Chapter 3, the impact of the APCNF per ha was analysed. Based on perha revenue generated, in that chapter, the aggregate benefits of the project have been estimated. The indicators considered in this analysis of potential benefits are- (1) saved expenditure on fertilisers and pesticides, (2) savings in total paid out costs, (3) additional crop wise output produced, and (4) additional revenue and profits generated.

Total 1,422 APCNF sample farmers have cultivated 2,044.98 ha during the study period. They have put 54.9% of the cultivated area under APCNF. It varies from 20.58 ha under

Chillies to 454.06 ha under Paddy. As total APCNF sample farmers are 1,422, and the average area would be0.79 ha per sample farmer, under APCNF. As per the information provided by RySS, about 5.80 lakh farmers have registered with RySS to practice APCNF during the Kharif 2019-20. Using the two figures, viz. the average area per farmer (1.44 ha) and total registered farmers with RySS (5.80 lakh), the total area under APCNF project during Kharif 2019-20 is estimated to be 4,57,920.21 ha. Using the percentages of each sample crop area in total sample area, the project level area under each sample crop is estimated from total project level estimated area. At the project level the area under sample crops vary from 8,394.30 ha under Chillies to 1,85,200.39 ha under Paddy (Table 5.1).

Table 5.1: Total estimated area under sample crops at APCNF project level

Area in ha and farmers in number

Crop	Sample area	Estimated area at Project level
Paddy	454.06	1,85,200.39
Groundnut	125.28	51,099.21
Cotton	89.75	36,605.78
Redgram	83.35	33,996.92
Jowar	71.07	28,986.85
Bengalgram	69.70	28,430.17
Black gram	47.41	19,335.61
Maize	46.25	18,865.09
Ragi	37.00	15,089.86
Sugarcane	30.55	12,458.91
Onion	25.40	10,358.13
Turmeric	22.31	9,098.98
Chillies	20.58	8,394.30
Total area	**1,122.69**	**4,57,920.21**
Total farmers	1,422	5,80,000
Area per farmer	*0.79*	*0.79*

Sources: Field Survey, 2019-20 and RySS

Using the crop wise per ha variations in fertilizers use, pesticides use, total paid out costs, yields, gross and net returns are discussed in chapter 3, and the project level estimated areas under the sample crops are presented at Table 5,1; the project level accomplishments are estimated and presented at Table 5.2.

The APCNF project has saved ₹475.49crore worth fertilisers use and ₹244.85crore worth pesticides use. There are far more health and environmental benefits from not using these agri-chemicals. The project has enabled the participating farmers to save ₹557.49crore in total paid out input costs; and to earn ₹576.88crore additional revenue and ₹1,134.38crof

profits. Each of 5.80 lakh project farmers have earned ₹19,558 net income from farming. This includes ₹9,612 from savings in paid out costs and ₹9,946 from additional yields and better prices (Table 5.2). There may be some marginal variations in these figures (+ or -10%), owing to sampling errors, especially at the bottom part of the table. Still these figures are close to reality and actually realized benefits by the project participants and the state. It may be noted that these are just from seasonal crops. There are additional net returns due to bund, boundary, inter crops, multiple layers, etc. In additions, the participant farmers are cultivating other crops, which are not covered in this study, which give more returns to the farmers.

Crop-wise savings in fertilisers vary from ₹4.76crore in Ragi to ₹179.91crore in Paddy; the same in pesticides vary from ₹0.22 crore in Ragi to ₹85.49crore in Paddy. The savings in the total paid out costs is in the range of ₹-15.79 crore in Sugarcane to ₹179.53crore in Paddy. The increase in crop output vary from -5.1603 thousand tons in Maize to 52.04 thousand tons in Paddy. While the gross returns increased from Rs-22.07crore in Maize to ₹198.18 crore in Paddy, the net returns increased in the range of ₹-6.01crore in Maize to ₹377.72crore in Paddy.

Table 5.2: Total savings in inputs and costs and increases in output and returns at the project level, due to APCNF

Units: Output in 1000 tons and all others in ₹ crore

Crop	Savings in Fertilizers	Savings in Pesticides	Savings in total costs	Increase in Output	Increase in gross returns	Increase net returns
Paddy	179.91	85.49	179.53	52.04	198.18	377.72
Maize	15.73	6.61	16.05	-5.03	-22.07	-6.01
Groundnut	29.30	11.58	24.01	0.79	26.29	50.30
Cotton	55.22	38.02	95.52	-2.10	-9.88	85.64
Chillies	44.73	33.63	51.47	3.44	55.24	106.71
Black gram	17.21	5.90	12.99	4.60	33.39	46.38
Bengal gram	26.47	10.37	46.00	0.74	24.18	70.18
Jowar	14.93	5.36	1.39	5.51	17.26	18.65
Ragi	4.76	0.22	15.09	5.93	18.99	34.08
Red gram	22.73	13.55	30.83	1.28	21.00	51.84
Sugarcane	9.98	3.58	-15.79	-3.86	23.90	8.11
Onion	28.62	13.85	43.76	18.90	123.42	167.18
Turmeric	25.90	16.67	56.63	10.08	66.97	123.60
Total	**475.49**	**244.85**	**557.49**		**576.88**	**1,134.38**
Per Farmerin ₹	*8,198*	*4,222*	*9,612*		*9,946*	*19,558*
Max of above	**179.91**	**85.49**	**179.53**	**52.04**	**198.18**	**377.72**
Min of above	*4.76*	*0.22*	*-15.79*	*-5.03*	*-22.07*	*-6.01*

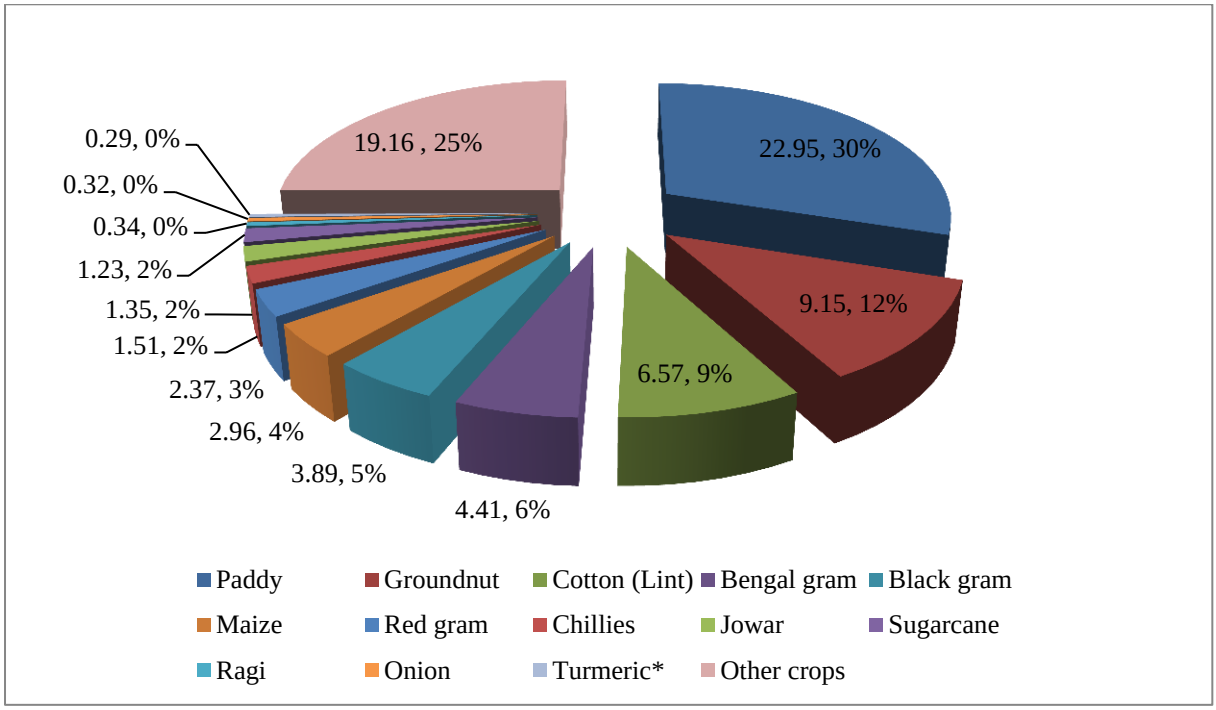
Sources: Field Survey, 2019-20 and RySS

5.3. State level potential benefits

The benefits discussed in the previous section are actual benefits, reaped by the project participants during the Kharif 2019-20. The scale of benefits, if the entire cropped area, in the state, is put under APCNF, is estimated in this section. As per Directorate of Economics and Statistics, Government of AP, the average gross cropped area (GCA) in the state during 2014-15 and 2018-19 is 76.50 lakh ha. Out of this area, the sample crops, together, are grown on 57.34 lakh ha; i.e. on 75% of total GCA. Crop wise area is shown at Figure 5.1. The area under the sample crops vary from 0.29 lakh ha under Turmeric to 22.95 lakh ha under Paddy. Using these areas under the sample crops and per ha rates discussed in chapter 3, the state level potential benefits, due to APCNF, in terms of savings in the agri-chemicals, savings in total paid out costs of cultivation, increase in crop outputs and increase in gross and net returns are estimated.

Figure 5.1: Area under sample and other crops in AP: average of 2014-15 to 2018-19

in lakh ha & percentages



Sources: Directorate of Economics and Statistics, AP, (2020)

Notes: Turmeric area is of 2018-19 only

Crop wise state level potential savings in expenditure on fertilizers, pesticides, and total paid out costs; increase in crop outputs and gross and net returns are presented at Table 5.3.If the entire sample crops' area is put under APCNF, the state/ farmers would have saved ₹6,061.58

crore worth fertilisers and ₹3,188.78 crore worth pesticides. The potential savings in the paid-out costs would be ₹6,937.01 cr. The gross returns would have increased by ₹5,523.31 crore and the net returns would be higher by ₹12,460.33 cr. The GDP from the crop sector would have increased by about 1%.

Across the sample crops, the savings in the expenditure on fertilisers would have been varied in the range of ₹10.72 crore in Ragi to ₹2,229.42 crore in Paddy. The same in pesticides would have been varied in the range of ₹0.50 crore in Ragi to ₹1,059.40 crore in Paddy. The savings in total paid out costs would have been in the range of ₹-155.91 crore in Sugarcane to ₹2,224.85 crore in Paddy. The increase in crop output would have been varied from -1.08 lakh tons in Sugarcane to 6.45 lakh tons in Paddy. The gross returns would have been increased from ₹-346.23 crore in Maize to ₹2,455.85 crore in Paddy; and the net returns would have been increased from ₹-94.37 crore in Maize to ₹4,680.69 crore in Paddy.

The total area under 13 sample crops is 57.34 lakh ha, which is equal to 75% of the total GCA in the state. Remaining area is under non-sample crops such as Bajra, other millets, Green gram, other pulses, other fibre crops, etc., and mostly under horticulture. APCNF is also practiced in almost all crops, including all horticulture crops. Applying the rates of changes obtained in the sample crops, the potential benefits from the entire GCA are estimated. If the entire GCA is put under APCNF, the state/ farmers would have saved ₹8,082.11 crore worth fertilisers and ₹4,251.71 crore worth pesticides. The potential savings in the total paid out cost would have been ₹9,249.35 cr. The gross returns would have increased by ₹7,364.42 cr; and the net returns would have increased by ₹16,613.77 cr.

Table 5.3: State-level potential savings in agri-chemicals and paid out costs and increase in crop output and gross and net returns, due to APCNF

Output in lakh tons & all other in ₹crore

Crop	Savings in fertilizers	Savings in Pesticides	Savings in paid out costs	Increase in crop output	Increase in gross returns	Increase in net returns
Paddy	2,229.42	1,059.40	2,224.85	6.45	2,455.85	4,680.69
Groundnut	524.63	207.42	429.87	0.14	470.78	900.65
Redgram	158.48	94.45	214.94	0.09	146.43	361.37
Cotton	991.01	682.43	1,714.39	-0.38	-177.27	1,537.12
Ragi	10.72	0.50	34.00	0.13	42.78	76.79
Maize	246.73	103.68	251.86	-0.79	-346.23	-94.37
Jowar	69.54	24.97	6.49	0.26	80.38	86.87
Bengal gram	410.54	160.93	713.58	0.11	375.06	1,088.64

Sugarcane	98.56	35.39	-155.91	-1.08	215.40	59.49
Black gram	346.29	118.66	261.32	0.92	671.82	933.13
Turmeric	82.54	53.14	180.50	0.32	213.44	393.95
Chillies	804.69	605.03	925.93	0.62	993.59	1,919.52
Onion	88.42	42.77	135.19	0.58	381.28	516.47
Total area under sample crops	**6,061.58**	**3,188.78**	**6,937.01**		**5,523.31**	**12,460.33**
Total GCA	***8,082.11***	***4,251.71***	***9,249.35***	**-**	***7,364.42***	***16,613.77***
Max of above	2,229.42	1,059.40	2,224.85	6.45	2,455.85	4,680.69
Min of above	10.72	0.50	-155.91	-1.08	-346.23	-94.37

Sources: Field Survey, 2019-20 and DES, 2020.

5.4. Potential yields under APCNF

In the previous section, potential benefits of APCNF at the state level were estimated, based on cropped areas in the state. In this section, potential benefits of APCNF has been analysed using the normal yields in the sample crops in the state. One of the shortcomings of this study is that the non-APCNF sample size is small in some crops, making the estimates and comparisons less reliable. To overcome this challenge, the state levels yields provided by the Directorate of Economics and Statistics (DES) have been used. DES gives the data after one year. Comparing the last years yields (as non-APCNF yields) with current year yields (as APCNF yields) is not a correct method. Instead the average yields of last five years (2014-15 to 2018-19) has been used. These yields, free from wider annual fluctuations, give some idea about the normal yields of the sample crops in the state. Two separate comparisons are made here: (1) the difference between 'the average of 10 top APCNF yields obtained from the field' and 'last 5 years average yields obtained in the state'; (2) the difference between 'the average yields of all APCNF yields' and "last 5 years average state yields". While the former comparison gives an idea about the potentials of APCNF in yields, the later address the issue of the small sample sizes in some crops. However, there is a bias in these comparisons. The yield data of APCNF pertains to 2019-2020. It may be noted that, as the sample was collected up to February 2020, some Rabi yields also got included. Hence the weighted average of Kharif and Rabi yields at the state level have been compared with the yields from the APCNF sample survey data.

The crop wise average of top 10 yields, the average APCNF yields, the state level yields and difference between them are shown at Table 5.4. As the state level 5-years average yields are not available for Onion and Turmeric, the crops are deleted from the analysis. The gap

between top 10 average yields and state level yields vary from -3.09 quintals per ha in Maize to 166.17 quintals per ha in Sugarcane. The rates of change vary from -4.79% in Maize to 497.70% in Cotton. The gap between (average) APCNF yields and the state level yields vary between -14.56 quintals in Maize to 13.66 quintals in Sugarcane. The rates of variation range from -22.57 in Maize to 251.58% in Cotton. Groundnut and Ragi also have recorded very high rates of change of 89.35% and 88.5% respectively. The variations in cotton and other rainfed cops, once again, indicate that APCNF is more effective under rainfed and irrigated dry-land crops. The relatively lower variations and declines observed in irrigated crops, especially in Sugarcane and Paddy indicates that APCNF needs supplementary measures under those conditions.

Table 5.4: Differences between APCNF potential yields and state level yields in the sample crops

Yields in quintals per ha; and differences in quintals and percentages

Crop	Average of top 10 yields	Average yield of all APCNF sample	5 years average yields in the state	Difference between top APCNF average yields and Five years average yields in the state Qtls	Difference between all APCNF average yields and Five years average state yields in Qtls	Difference between top APCNF average yields and Five years average state yields in %	Difference between APCNF average yields and Five years average state yields in %
Paddy	69.22	50.87	53.12	16.10	-2.25	30.32	-4.24
Maize	61.43	49.96	64.52	-3.09	-14.56	-4.79	-22.57
Groundnut	26.19	16.53	8.73	17.46	7.80	200.04	89.35
Cotton	32.22	18.95	5.39	26.83	13.56	497.70	251.58
Chillies	53.01	49.78	47.91	5.10	1.87	10.65	3.90
Black gram	18.33	12.62	8.42	9.91	4.20	117.70	49.88
Bengal gram	19.08	15.57	11.34	7.74	4.23	68.26	37.30
Jowar	25.06	20.15	22.3	2.76	-2.15	12.36	-9.64
Ragi	25.83	20.81	11.04	14.79	9.77	133.95	88.50
Red gram	10.64	6.47	4.96	5.68	1.51	114.44	30.44
Sugarcane	930.53	778.02	764.36	166.17	13.66	21.74	1.79
Max of above	930.53	778.02	764.36	166.17	13.66	497.70	251.58
Min of above	10.64	6.47	4.96	-3.09	-14.56	-4.79	-22.57

Sources: Field Survey, 2019-20 and DES, 2020

** Rabi yields # yearly yields*

5.5. New marketing channels and prices

As of now, RySS has not initiated the market interventions. There are a few local initiatives by the District Project Managers (DPMs) and local officials. However, some of the farmers could sell APCNF crop output in variety new market channels and realized higher prices.

Crop wise and market channel wise amounts sold by APCNF and non-APCNF farmers has been shown at Table 5.5. The major change is that the farmers have reduced their APCNF crop output sales in the regulated markets controlled by agriculture production market committee (APMCs), popularly known as "market yards", which are considered as most oppressing marketing channel.[5] Most of the APCNF outputs are being sold in the local markets, which include friends, relatives and local shops. It implies local interest in the APCNF output. Small quantities of APCNF products are sold to factories, cooperatives, urban consumers, online markets and others. Over 11% of Turmeric has been sold online.

Table 5.5: Percentage of crop output sold through different market channels by APCNF and Non-APCNF farmers

	Paddy		Groundnut		Chillies		Jowar	
Market channels	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF
1	2	3	4	5	6	7	8	9
Market yard	2.62	10.06	6.61	17.71	48.60	68.52	4.88	-
Private Traders	56.22	59.40	38.25	61.07	44.44	29.44	82.49	82.85
Local markets	38.69	29.80	54.72	21.22	4.67	2.04	12.63	17.15
Factories	0.42	0.32	-	-	-	-	-	-
Cooperatives	0.13	-	-	-	-	-	-	-
Urban consumers	0.44	0.43	0.43	-	-	-	-	-
Online marketing	1.20	-	-	-	2.30	-	-	-
Others	0.29	-	-	-	-	-	-	-
Total in %	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total in Qtls	23791.19	14847.01	3095.01	778.84	2150.70	2306.90	1529.25	826.05

Sources: Field Survey, 2019-20

Table 5.5: Cont.

	Red gram		Onion		Maize		Cotton	
Market channels	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF
1	10	11	12	13	14	15	16	17
Market yard	4.11	10.75	17.95	40.94	3.13	3.24	14.89	11.08
Private Traders	76.34	76.17	57.58	46.56	53.72	40.29	76.50	66.19
Local markets	18.67	13.08	24.47	12.50	41.51	56.47	8.61	22.74
Factories	-	-	-	-	-	-	-	-
Cooperatives	-	-	-	-	-	-	-	-
Urban consumers	0.58	-	-	-	1.63	-	-	-
Online marketing	0.30	-	-	-	-	-	-	-
Others	-	-	-	-	-	-	-	-
Total in %	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total in Qtls	2492.41	535.90	5575.51	3116.50	6045.69	3734.93	3020.38	1961.85

Sources: Field Survey, 2019-20

[5] The Government of India initiated reforms in agriculture marketing; reduced the scope, and powers of APMCss

Table 5.5: Cont.

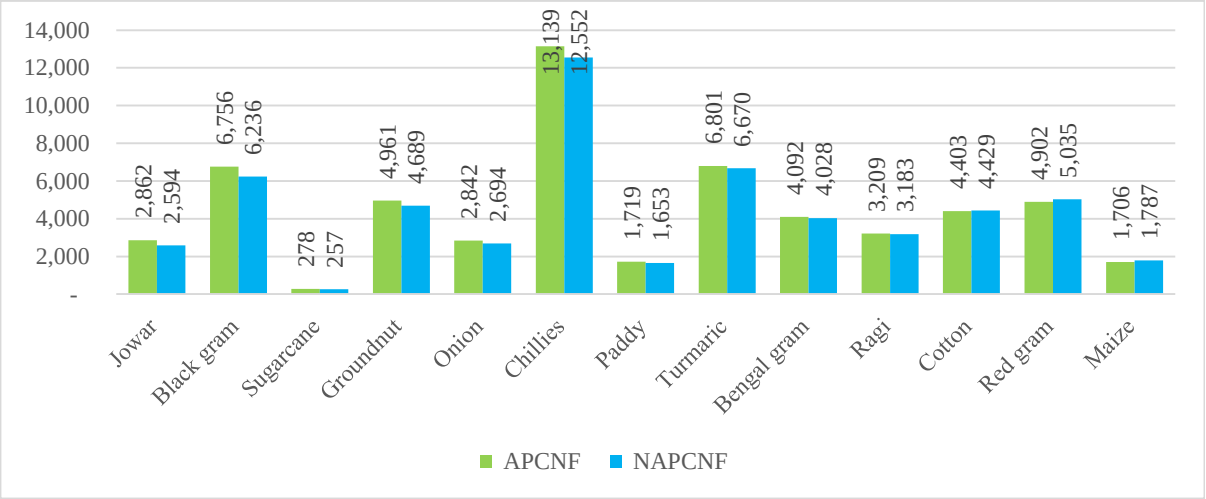
	Black gram		Bengal gram		Ragi		Sugarcane		Turmeric	
Market channels	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF	APCNF	Non-APCNF
1	18	19	20	21	22	23	24	25	26	27
Market yard	3.39	-	5.08	3.50	1.33	-	5.70	-	11.43	46.91
Private Traders	81.71	95.87	86.38	89.12	7.90	9.10	12.63	0.69	48.92	43.40
Local markets	14.45	4.13	8.54	4.66	90.77	90.90	0.66	-	25.74	9.70
Factories	-	-	-	-	-	-	81.02	99.31	-	-
Cooperatives	-	-	-	-	-	-	-	-	-	-
Urban consumers	0.44	-	-	2.72	-	-	-	-	2.30	-
Online marketing	-	-	-	-	-	-	-	-	11.61	-
Others	-	-	-	-	-	-	-	-	-	-
Total in %	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Total in Qtls	837.10	194.40	1106.23	763.51	740.62	237.69	47077.16	22585.54	3576.26	1200.58

Sources: Field Survey, 2019-20

One of the critical issues is to know, whether APCNF crops are fetching higher prices or not. The weighted average prices realized for APCNF and non-APCNF crops are shown in Figure 5.3. Out of 13 sample crops, 10 APCNF crops got higher prices, and three crops received lower price. Out of the 10 crops, Jowar got highest margin of 10.34%. The prices received were higher for two crops by more than 8% and another two crops by more than 5% . Out of the three crops, which fetch lower prices for APCNF output, the margin varies from 0.58% in Cotton to 4.50% in Maize.

Figure 5.2: Weighted average prices of APCNF and Non-APCNF crops' outputs

₹ per quintal



Sources: Field Survey, 2019-20

5.6. Additional employment generation

One of the major criteria adopted in India to judge any new technology, enterprise, practice, etc. is to look at its employment potential. The study has generated a wealth of data about labour use in different agriculture operations, use of own and hired labour in hours. The eight major agriculture operations considered are: (1) Preparatory Cultivation, (2) Seedling / Nursery. (3) Transplantation, (4) Inter-cultivation/ weeding, (5) Irrigation, (6) Input application, (7) Harvesting, and, (8) Threshing, Transport and Marketing etc. The hours are totalled and converted into days at the rate of 8 hours per day.

Before discussing the variations in labours use in APCNF and non-APCNF crops, few theoretical issues of labour-intensive agriculture may be recalled. Labour being an input in the agriculture, minimizing labour use would reduce the hired labour cost. However, if increase in expenditure on labour is more than compensated by reduction in other inputs, it is profitable. Further, as can be seen below, if increase in labour use increases crop output, labour productivity in agriculture goes up. it is also desirable. In India in general and in AP in particular, it is well-known that the youth, in agricultural households (AHHs), is not migrate from agriculture/ rural areas to non-farm sectors, including the informal sectors, in the urban areas. Labour intensive natural farming has the potential of increasing labour absorption in agriculture and reduce distress migration. As per the Socio Economic and Caste Census (SECC) 2011, about 3.7 per cent rural households do not have a working age (19-60 years

age group) members, in the country. This must be quite high in the South India, especially, in the migration obsessed Andhra Pradesh.[6]

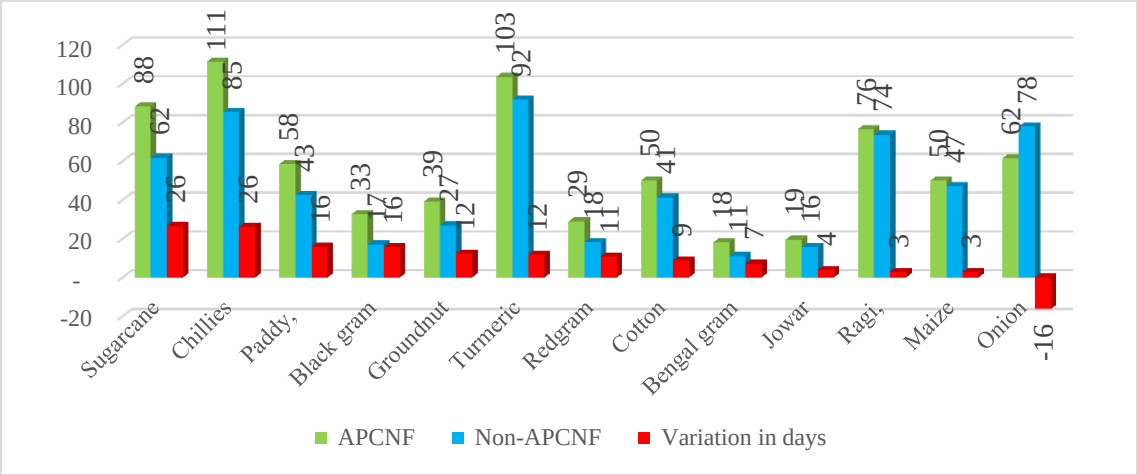
The summary of crops wise own labour use per ha under APCNF and non-APCNF cultivation are presented at Figure 5.3. Under APCNF, the highest family labour is used in Chillies (111 days) per ha followed by Turmeric (103 days) and least amount of family labour is applied in Bengal gram (18 days).Under non-APCNF, own labour is used from 11 days per ha in Bengal gram to 92 days in Turmeric. Out of 13 crops considered here, a greater number of days of family labour is applied in 12 crops. The highest additional family labour, under APCNF, is applied in Sugarcane (26 days) per ha and least number of additional own labour is applied in Maize (3 days) per ha. One of reasons for employment of additional family labour is under the Sugarcane is due to preparation of Jaggery by some of APCNF farmers.

In Onion, relatively lesser number of own labour (62) days are employed, under APCNF, compared to 78 days under non-ACNF. The major reason is the additional Onion yields obtained under APCNF; by more than 18 quintals. Additional hired labour might have been employed to harvest and post-harvest operations. Another reason could be that Onion prices went up very high during the study period. The Onion farmers have increased area under the crop and completed many operations quickly, employing additional hired labour. Additional cost on labour, in this context, is more desirable.

Figure 5.3: Crop wise own labour used under APCNF and Non-APCNF & variations

Labour days per ha

[6] The population density in Andhra Pradesh in 2011 was less than that of Telangana; the same was significantly higher than that of Telangana region in 1961. It shows the exodus from the state. It may be noted that the development literature indicate that young, energetic and qualified people migrate in search better opportunities, leaving behind the aged and vulnerable.



Sources: Field Survey, 2019-20

Crop wise total number of labour days, including own and hired labour, used per ha, under APCNF and non-APCNF are presented at Table 5.6. Under APCNF, labour use varies from 45 days per ha in Bengal gram to 509 days in Chillies. The same under non-APCNF varies from 44 days in Bengal gram to 424 days in Chillies. Out of 13 sample crops, a greater number of labour days are used in nine crops, under APCNF, in the range of one day in Bengal gram and Red gram to 85 days.

Table 5.6: Crop-wise total number of labour days used under APCNF & Non-APCNF

Days per ha

Crop	Labour days used under APCNF	Labour days used under Non-APCNF	Difference in days	Difference in %
Chillies	509	424	85	20.13
Groundnut	107	78	28	36.37
Paddy,	111	93	18	19.90
Sugarcane	267	249	18	7.26
Black gram	61	47	14	30.24
Onion	197	191	6	3.07
Maize	111	105	6	5.44
Red gram	47	45	1	3.20
Bengal gram	45	44	1	2.63
Jowar	49	51	-2	-3.02
Cotton	144	153	-9	-5.89
Ragi,	101	119	-18	-15.13
Turmeric	301	354	-53	-15.00
Max of above	509	424	85	36
Min of above	45	44	-53	-15

Sources: Field Survey, 2019-20

In total, APCNF project has generated 54,50,364 days of additional employment for the own labour and 52,15,612 days of additional employment for both own and hired labour. It implies, the project has resulted in the net loss of 2,34,752 days of employment for the hired labour. APCNF project has generated about 12 person days of additional employment per ha for the family labour. But, generated a little over 11 days of additional total employment, including own and hired labour, per ha. It implies there is a marginal decrease of about half a person day per ha in employment generation for hired labour.

5.7. Conclusions

The project is yielding excellent results. During the Kharif 2019-20, APCNF has prevented the use of ₹475.49crore worth of fertilisers and ₹244.85crore worth of pesticides. These savings have resulted in the larger environmental and health benefits. The project has enabled the APCNF farmers to save ₹557.49crore in total paid out costs and realize ₹1,134.38crore additional net returns; i.e. ₹19,558 per APCNF farmer. Had the entire crop area in the state put under APCNF, the GDP from the crop sub-sector would have increased by about 1%. When compared with normal yields achieved in the state during last five years, APCNF yields are higher by substantial margins in 12 out of 13 sample crops. The average yields of top 10 performers of APCNF indicate a huge potential to increase the crop yields. Some of the APCNF farmers, on their own, are able to market their products in new market channels and realize higher prices.

Though there is a marginal decline of about half a day per ha in total employment generation due to APCNF, there is a marked increase in demand for the family labour by about 12 days per ha. The major reason is the nature of the preparation of biological inputs, which involves smaller tasks such as collection and gathering of inputs such as cow dung, cow urine, leaves, etc; cleaning, grading, storing of raw materials/ inputs; soaking; drying; grinding; mixing; fermenting; etc are scattered over several days have to be performed by the family members only. Thus, availability of the family labour may be a potential constraint in the expansion of APCNF in the coming years. RySS may ponder on this issue rather seriously. However, the positive feature of APCNF is that it is resulting in improved financial, health and environmental outcomes. Will these improvements halt and reverse the youth migration from agriculture in the state?

Chapter 6: Issues, Challenges and Policy Options

6.1. Introduction

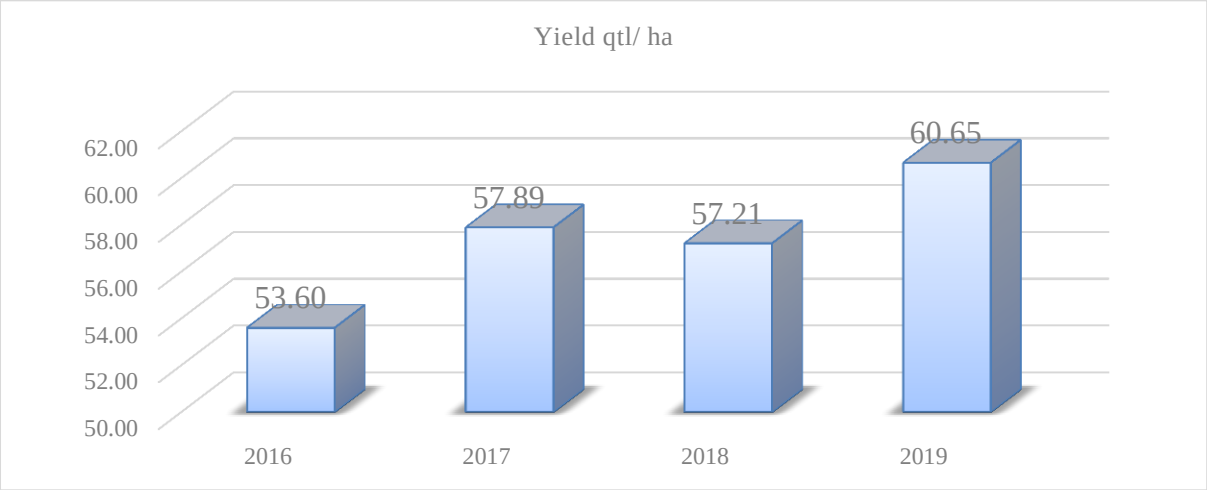
This concluding chapter presents the issues and challenges identified in this report, field survey and strategic interviews and policy options are discussed.It is well established from this study and earlier studies that APCNF is highly beneficial, compared to conventional agriculture. It is resulting in significant savings in the expenditure on PNPIs, and in total paid out cost. It is enabling the farmers to get higher gross and net returns. As APCNF is reducing the expenditure on the paid-out costs, the increase in net returns is always higher than the gross returns. The programme is getting widespread acceptance from the farming community. The number of participants-farmers and area under APCNF has been growing at past face. However, there are certain issues and challenges, which need attention of the RySS. These include fluctuations in yields of certain crops, marketing, preparation and use of biological inputs, etc.

6.2. Less than anticipated and fluctuating yields

The yields of most of the crops, under APCNF, are at least equal or higher than that of non-APCNF during last two years. However, some crops are consistently yielding lower than non-APCNF yields. For example, in Paddy, the principal crop in the state, the APCNF yields, during last year, were less than that of non-APCNF. Though the APCNF yields are higher that the non-APCNF yields, this year; it is less than the average of last five years yields of the state. Some of the crop yields under APCNF have fluctuated from last year yields. E.g. the APCNF yields of Maize were higher than non-APCNF during last year by a significant margin. But this year Maize yields, under APCNF, are less than the non-APCNF yields. In fact, the average Maize yields of top 10 APCNF are less than the average state yields during last five years. Most of the DPMs, have said in the SIs that the crop yields have to be improved and stabilized to attract more farmers into the project and retain the existing farmers.

Another issue observed this year with respect to yields is that in Paddy, the yields obtained by the farmers, who have started APCNF in 2016, are less than that of the farmers started APCNF in 2017, 2018 and much less than that of 2019 batch farmers (Figure 6.1). One possible reason could be that the crop yields under APCNF would remain high during 1st and 2nd year under APCNF, due to availability of residual nutrients from chemical fertilisers, applied during the earlier years. One possible reason is that as the yields used in this figure are the farmers reported yields; it is possible that early starters might have under reported, by bigger margin, than others to avoid unnecessary attention and publicity.

Figure 6.1: Reported Paddy yields of the sample farmers as per their starting year under APCNF

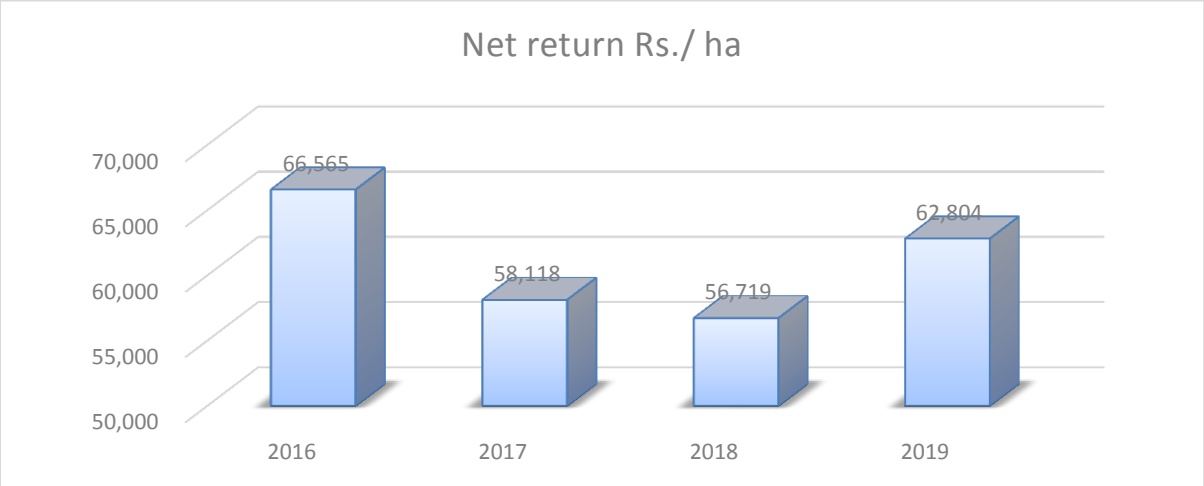


Sources: Field Survey, 2019-20

It is interesting to note that the farmers, who started in 2016, got lesser Paddy yields than others; but they got higher net returns than the late comers (Figure 6.2). The possible reasons could be- (1) that the early starters might have perfected the art to keep down the cost of cultivation; (2) the soil quality might have increased and resulted in savings in crop husbandry expenditure; and (3) the early starters might have developed alternative market channels and realized better prices. Yet another possible and plausible reason could be that the early starters might have under reported their yields by bigger margin than other farmers.[7]

[7] To overcome the issues of strategic under reporting in the yields, the study has conducted CCEs to estimate the yields independently and scientifically, which are used throughout this report. However, those estimates could not be used in this context due to some technical issues.

Figure 6.2: Net returns from Paddy under APCNF, as per the farmers' starting year (Based on reported yields)



Sources: Field Survey, 2019-20

6.3. Higher demand for human labour

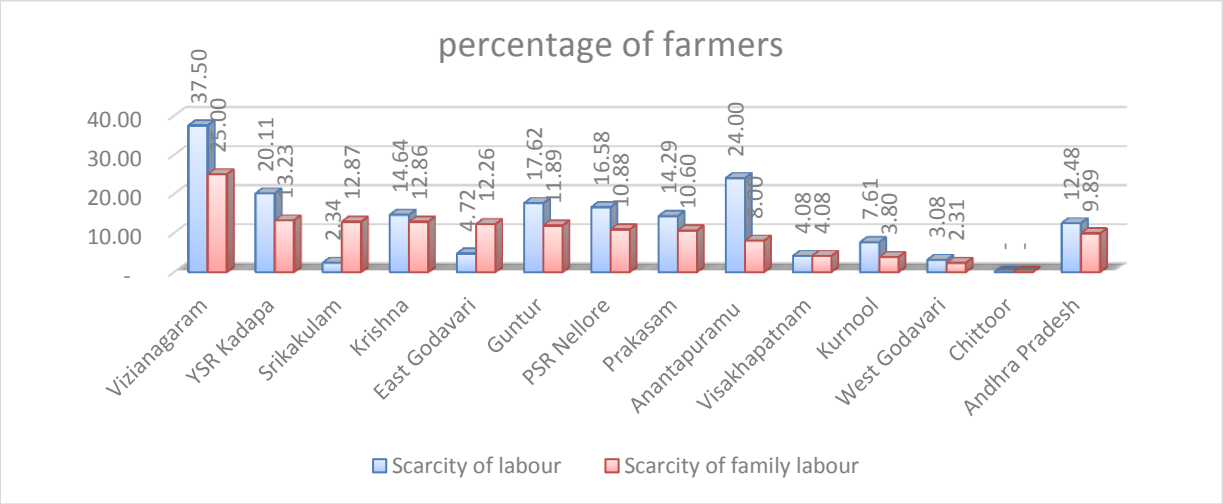
The issue of labour availability in agriculture in general in India, in AP in particular, is grossly neglected. The underlying assumption is that there is an abundant labour supply. The fact is, as the agriculture growth is not keeping pace with other sectors in the economic development, it is not able to retain and attract the labour supply. As a result, AHH are adapting the agriculture strategies to minimize the need for the labour, such as mechanization, mono-cropping, use of short duration varieties of crops, use of readymade inputs, contract labour, share-cropping, not rearing livestock, etc. In India in general and in AP in particular, it is well known fact that the youth, in AHHs, is not interested in the farming, and also their parents are not encouraging them to be in the farming. There is enough evidence about relentless youth migration from agriculture/ rural areas to non-farm sectors, including the informal sectors, in the urban areas. As per the Socio Economic and Caste Census (SECC) 2011, about 3.7 per cent rural households, in the country, do not have a working age (19-60 years age group) members. This must be quite high in the South India, especially, in the migration obsessed Andhra Pradesh. It may be noted that APCNF is, predominantly Indian traditional farming system. Shortage of labour was one of the reasons for discontinuity of the some of the agriculture practices such as application of FYM, silt from the water bodies, mulching, rearing of cattle, etc. Because of the shortage of labour the AHHs in the state are keeping less livestock. As per the NSSO survey 70th round, only 48.6 per cent Agriculture Households (AHHs), in the state, rear the bovine livestock; the same at all India level is 62.7

per cent. In the states like Punjab and Haryana about 95 per cent AHHs held the farming animals. There is a forced mechanization of agriculture in the state.

In the previous chapter, it is noted that use of family labour is higher under APCNF, in 12 out of 13 sample crops; on average about 12 additional days of family labour is used per ha across all crops. In nine out of 13 crops, the total labour (own + hired) used is high under APCNF; on average over 11 additional days of total labour is used per ha across all crops. It implies a net decline of about half a day employment for hired labour per ha. Further, preparation of biological inputs, which involves a number of smaller tasks such as collection of inputs such as cow dung, cow urine, leaves, etc; cleaning, grading, storing of raw materials/ inputs; soaking; drying; grinding; mixing; stirring; fermenting; etc are scattered over several days; hence, have to be performed by the family members only. In this context, the labour availability may become a potential constraint in the expansion of the APCNF in the coming years. Further, APCNF also need higher doses of bullock labour, due to intensive and mixed cropping, and FYM.

When asked about the challenges faced by the project participants in adopting the APCNF, they have given number of responses. At the state level, about 10% farmers has reported the shortage of family labour as the main issue; and about 12.5% has reported the shortage of labour as the focal issue. Further, 5.18% has reported other issues, which are mostly related to labour shortages such as problems in nursery raising and transplantation. Across the districts, the problem of family labour shortage is very high in Vizianagaram (25%) followed by YSR Kadapa (20.11%) and least in Chittoor (0%), proceeded by West Godavari (2.31%). Highest shortage of labour is reported in Vizianagaram (37.50%) followed by Anantapuramu (24%) and least shortage is reported in Chittoor (0%), preceded by Srikakulam (2.34%) and West Godavari (3.08%). See Figure 6.3.

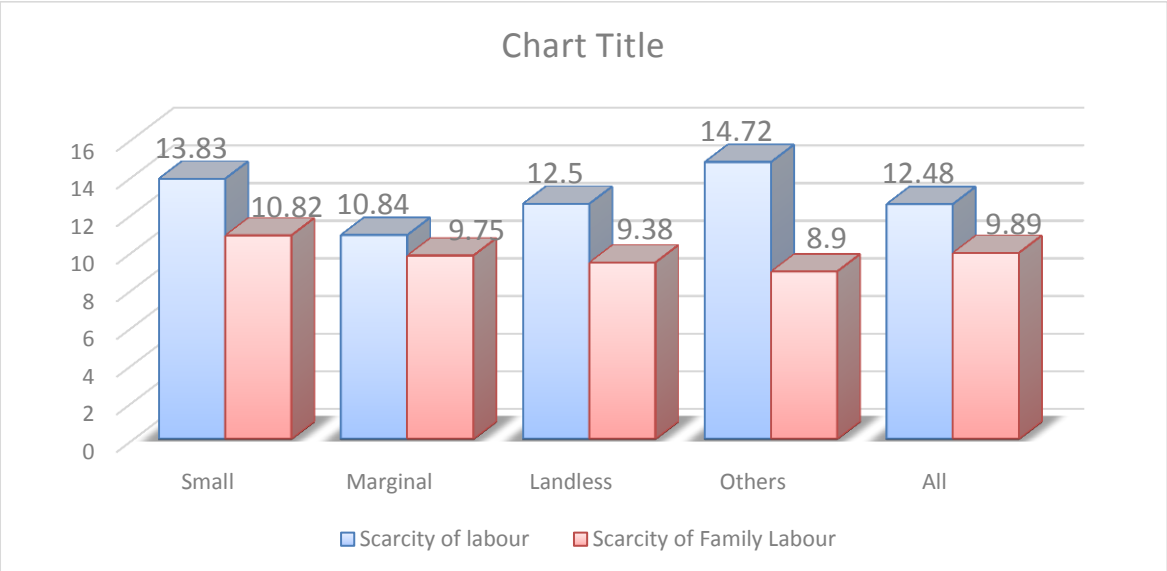
Figure 6.3: District-wise sample farmers reported the shortage of labour and family labour as main issue under APCNF



Sources: Field Survey, 2019-20

Across the farmers' categories, the small farmers have reported main issue is the shortage of family labour (10.82%), followed by marginal farmers (9.75%) and landless (9.38%). Relatively lesser number of other farmers (8.9%), which include medium and large farmers, who normally are less dependent on family labour, have reported the shortage of family labour as a principal issue. As expected, relatively higher percentage of other farmers (14.72%), followed by small farmers (13.83%) and landless (12.5%) have reported shortage of labour (own + hired) as a major issue (Table 6.4).

Figure 6.4: Farmers' category-wise reported shortage of labour and family labour as main issue under APCNF



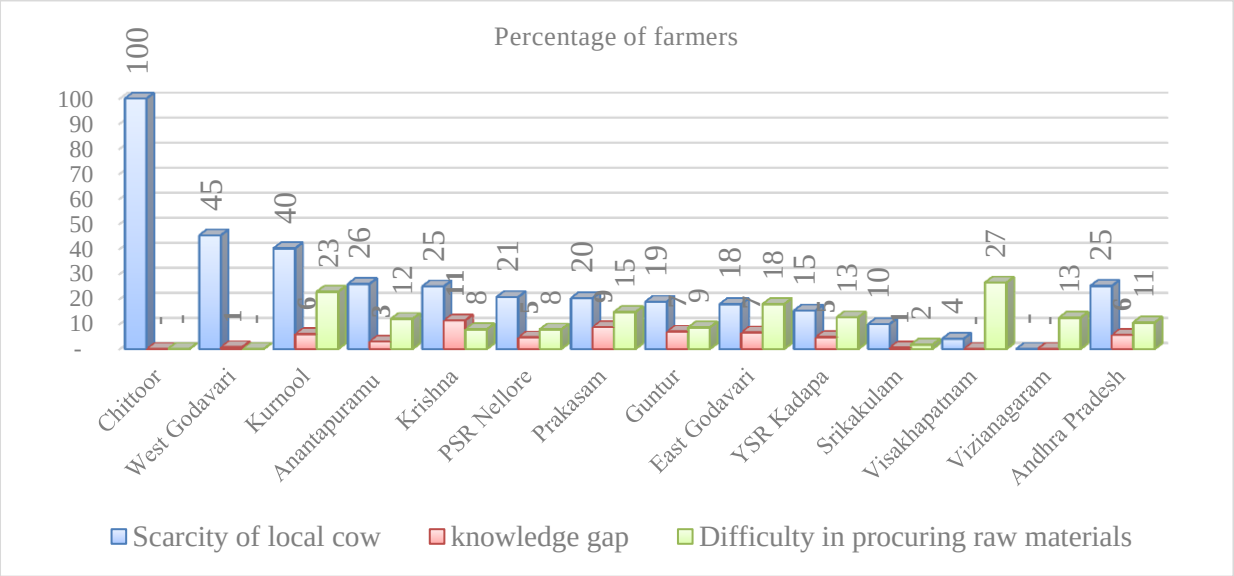
6.4. Shortage of raw material

Yet another problem that is widely reported by the APCNF farmers is non-availability of biological inputs in the market. As mentioned above farmers, to reduce the labour input in cultivation, are using, extensively, the readymade inputs. Non-availability of readymade APCNF inputs may be discouraging farmers to adopt APCNF practices. It is even more challenging that some of raw materials, such as Desi cow dung, urine, etc., to prepare the biological inputs like Jeevamrutham, are not available in many places. As mentioned above less than 50 per cent AHH in the state are farming the livestock. Further, the shortage of Desi/ local/ indigenous cows/ cattle is acute in some areas. Because of degradation and disappearance of the common lands, the availability of many trees such as Vepa (Neem), Tangedu (Senna), etc, used for mulching and Kashayams are not available. More than these the farmers appeared to be handicapped by the shortage of the family labour and ***knowledge for the preparation of the biological inputs***.

At the state level, over 25% of APCNF sample farmers have reported that not availability of the Desi cow is the foremost challenge. Another 11% farmers have stated that difficulties in collecting, gathering and procuring the raw materials is a severe issue, and yet another 6% have informed that they do not have adequate knowledge and skills to prepare the biological inputs- Jeevamrutham and Kashayams/ Asthrams (Figure 6.5).

District wise, all 100% APCNF farmers, in Chittoor district, have conveyed that shortage of Desi cow is the number one issue. On the other hand, none of APCNF farmers felt the non-availability of Desi cow as an issue in Vizianagaram. While none of the farmers in Chittoor, Vizianagaram and Visakhapatnam, specified any gap in their knowledge and skill in preparation of the biological inputs, about 11% farmers in Krishna district have admitted that they are short of knowledge in preparation of the biological inputs. Number of farmers, who find difficulties in the procurement of raw materials for the biological inputs vary between 0% in Chittoor and West Godavari to 27% in Visakhapatnam.

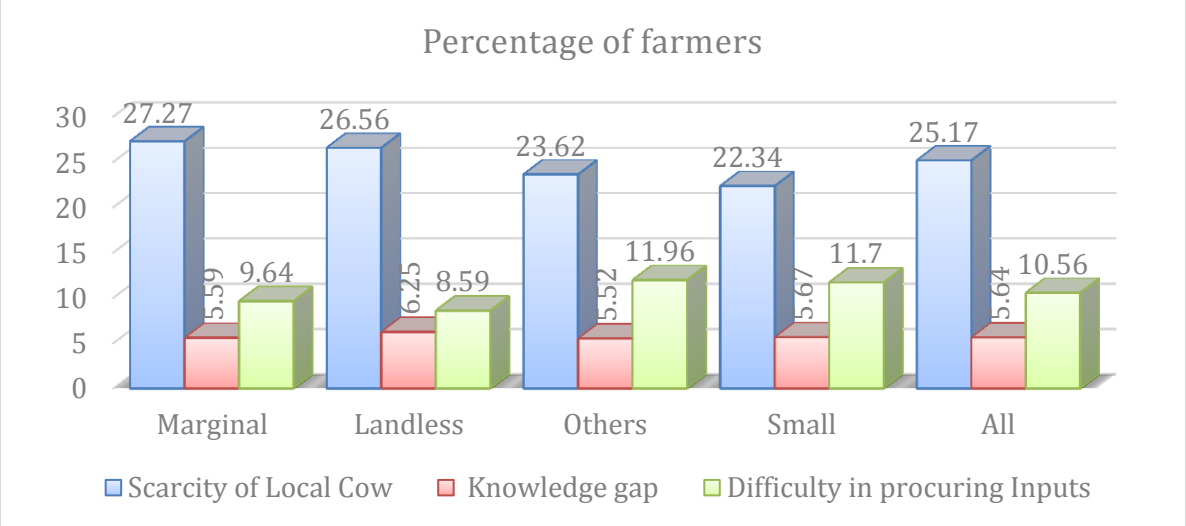
Figure 6.5: Districts-wise sample APCNF farmers' experiences in preparation of biological inputs



Sources: Field Survey, 2020

In terms of the challenges with respect to preparation of biological inputs, there is no big gap among different categories of the farmers. Farmers, who experienced a scarcity of Desi cow vary from 22.34% among the small farmers to 27.27% in marginal farmers. Farmers in the range of 5.52% of other farmers to 6.25% of landless farmers said that they do not have adequate knowledge to prepare the biological inputs. Procurement of raw materials for the preparation of biological inputs is difficult task for 8.59%of landless farmers to 11.96% of other farmers (Figure 6.6).

Figure 6.6: Farmers category-wise sample APCNF farmers' experiences in preparation of biological inputs

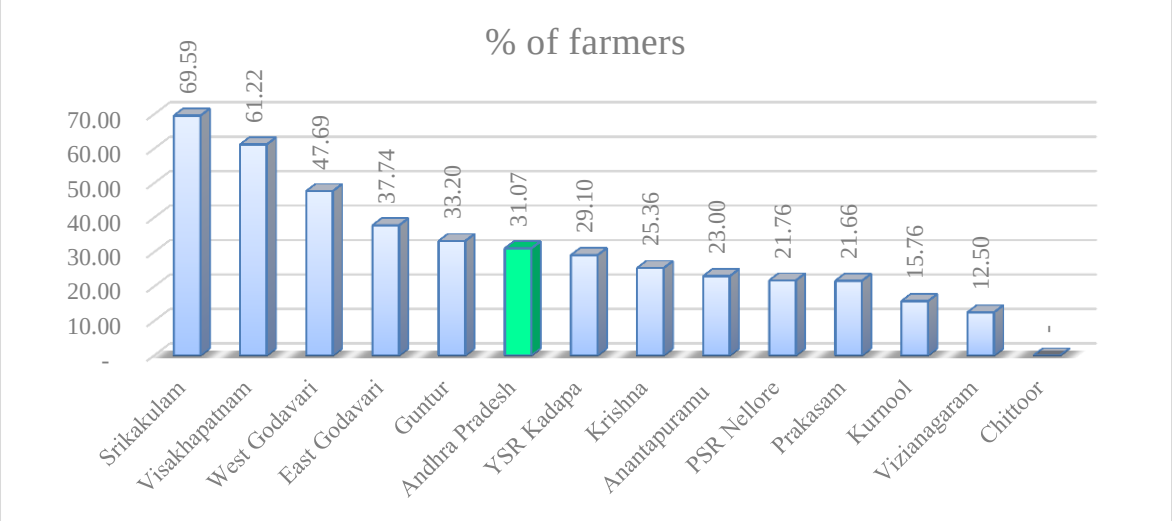


Sources: Field Survey, 2019-20

6.5. Marketing

The net returns, under APCNF, are substantially higher than that of Non-APCNF in most of the crops.These higher returns came at higher cost of family labour, which is not included in the cost of cultivation analyses in this report. The farmers are expecting premium prices to compensate their higher family labour input. Out of total APCNF sample farmers, 31% farmers said that marketing is their number one challenge. The same is as high as 69.59% in Srikakulam, followed by Visakhapatnam (61.22%) and as low as 0% in Chittoor, preceded by 12% in Vizianagaram (Figure 6.7). It appears the marketing a serious problem in the Tribal areas.

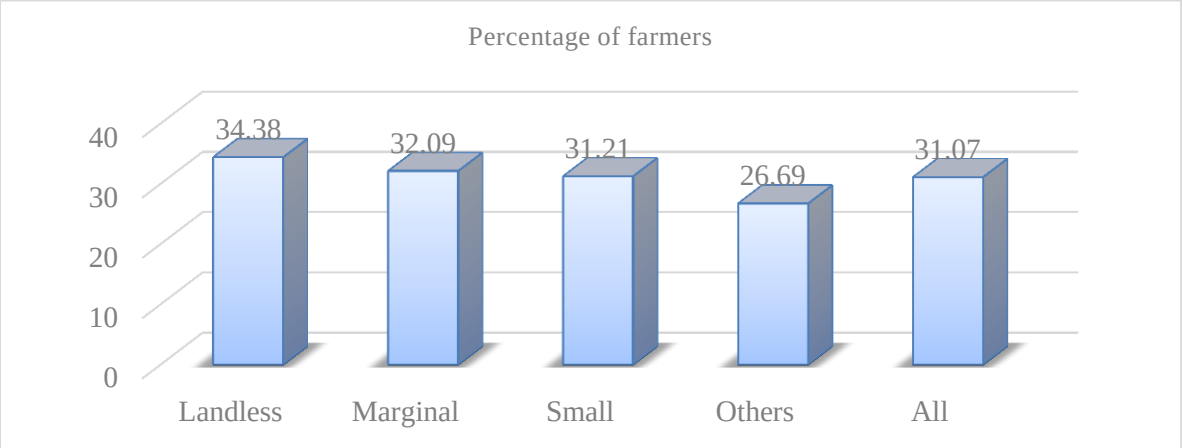
Figure 6.7: District-wise sample APCNF farmers reported marketing as the major problem



Sources: Field Survey, 2019-20

Over 31% of all categories of farmers have stated that marketing of output is their major problem. The same varies from 26.69% in other farmers to 34.38% in landless farmers; the gap is more than eight percentage points. It clearly shows that poorer sections need support in marketing of their agriculture output (Figure 6.8).

Figure 6.8: Farmer category-wise farmers reported marketing as the major problem



Sources: Field Survey, 2019-20

6.6. Slow progress in model crops

The project has introduced several measures to improve the cropping pattern, cropping intensity, crop rotations, etc. The models include 5-layer, 7-layer, 36X36, integrated farming, PMDS cropping, bund-cropping, border-cropping, inter-cropping, etc. However, the progress on the model crops is rather slow. In the sample, less than one third farmers have adapted any of the model crops. Precisely, 24 sample farmers have adapted the multi-tier cropping models and another 24 sample farmers have adapted the PMDS cropping.

6.7. Project implementation

While all the benefits described in chapter 3 to chapter 5 are due to the project, most of the issues and challenges are also the result of project implementation strategies and practices. Over five per cent sample farmers said that they do not have adequate skills and knowledge to prepare and apply the Kashayams and Asthrams to control pest attacks on crops. The farmers are feeling that the extension services are not available in time. At the same time, the PDMs and other field staff feel that they have been overstretched. The major challenge is that the project is being implemented in isolation, with its own resources. Many of the PDMs have said this problem.

6.8. Policy Options for yield enhancement and stabilization

The study results indicate that microorganism, introduced and incorporated in the soils, appeared to be less effective under completely degraded soils and harsh environment such as Anantapuramu and canal/ flood irrigation crops such as Paddy and Sugarcane. Tree based farming models may be one good option to improve the soil quality and local environment. Over the time the trees give very good returns. ***BAIF's Wadi model is one good example***. There are many other examples in Anantapur district, which demonstrated that protection of wild trees in the hills have improved the micro-climate and local soils' quality and productivity significantly. ***The Government may provide the carbon credits or cash payments for carbon sequestration services to the farmers who grow the trees on their fields. Variety of models could be designed with different combinations of forest species, horticulture species, and other fruit bearing trees, fodder tress, vegetable species, medicinal plants, etc, as per the local conditions.***Introduction of forest species in the farmers' fields need the abolition of the Forest Department's monopoly on, and, need for permissions for, rising, harvesting and marketing of all the forest species.

An effective method in flood/ canal irrigation areas and crops would be SRI to enhance the crop yields.

6.9. Policy Options for labour shortage

Allow and facilitate the farmers to grow forest species- trees, shrubs, herbs and creepers, which give timber, high value wood, poles, medicinal products, cosmetics, spices, wild fruits, wild vegetable, etc. Trees like Sandalwood, Red sander, Teak, Coconut, Dates, Eucalyptus, Subabul, Tamarind, Amla, Bamboo, Casurena, etc, variety of fodder trees, shrubs and herbs like Aloe Vera, Lemongrass and creepers like TippaTeega (Giloy), etc, which have medicinal and cosmetics values, along with local seasonal crops can give very good returns in the short run. *These species need very little human and family labour* and give a steady flow of products, services and income perpetually. If grown on about 30 per cent of the field/ plot, they improve the soil quality and micro-environment naturally. Thick forests are good example for natural regeneration of the soils.[8]The crop yields on the remaining part of the

[8] Subash Palekar, the father of natural farming, himself cited this example in his famous book- The Philosophy of Spiritual Farming.

field/ plot would be significantly higher. BAIF's Wadi model is one good example. The Government may provide the carbon credits or cash payments for carbon sequestration services to the farmers who grow the trees on their fields.

Facilitation of production and supply of biological inputs on commercial basis will reduce the need for family labour. Another option is facilitating and encouraging the formation of farmers groups and share their labour, just like SHG groups. The tree-based farming, if promoted, will improve soil quality and micro environment naturally and reduce the need for frequent application of the biological inputs.

6.10. Policy options to boost the supply of biological inputs and raw materials

The Village level and/ or Mandal level association of Self-help Group Institutions may be facilitated to produce and supply the biological inputs to the APCNF farmers at the mutually agreed prices. Such arrangement would resolve the problem of availability of raw materials such Desi cow dung, cow urine, leaves and seeds of different trees, etc in some villages. The progressive farmers or internal community resource persons (ICRPs) may be facilitated to prepare and supply these products to the needy farmers. As per the DPMs in the SIs, the project is already implementing this strategy in some places. The project may enlarge the scope of the program. If tree-based farming is promoted, the available biomass would encourage the farmers to rear more livestock, including the Desi cow. The tree species needed for the preparation of biological inputs may also be grown under the tree-based farming.

6.11. Policy options for market interventions

RySS may start the market interventions soon. Marketing problems have been handled in different ways in districts as reported by the DPMs. Rythu Bazars are being used in all the districts. Organic Stalls have been promoted in Chittoor district. Individual Entrepreneurs have emerged as middlemen of purchasing from farmers and selling to consumers. FPOs promoted by NGOs in tribal areas especially for Gulli Ragi crop emerged where large volumes are available for marketing. The small and marginal farmers are not able to market their product for premium prices. Medium and large farmers who are educated and progressive are able to sell their products utilising modern supply chains. Certificates are given for the farmers who have been growing crops under natural farming for three years like

ICRPs in Guntur and Chittoor that the farmers growing crops continuously for three years under APCNF. Apart from continuing these initiatives, RySS may initiate the following measures:

a. RySS may facilitate the procurement of APCNF products for the Public Distribution System (PDS), School Mid-day Meals, Anganwadi programs, etc.
b. RySS may rope in the Girijan Cooperative Corporation (GCC) in the marketing of the APCNF products, at least in the Tribal areas.
c. RySS can facilitate tie up between big malls and certain villages/ mandals. The SHG institutions may also be roped in for simple preparation of agri-products/ food processing such as cleaning, grading, grinding, deseeding, shelling, packing, etc.
d. As and when the medicinal plants and cosmetic related plants are introduced in the farming systems, simultaneously, their processing and marketing interventions have to be initiated.

6.12. Policy Options for Project implementation

The project has to change its implementation strategies to cover all farmers and the entire GCA in the state, at the earliest. The possible options are:

a. There is a crucial need for a complete integration or a close coordination of all departments dealing with natural resources such as agriculture, rural developments, animal husbandry, forestry, civil supplies, etc. Such integration enables the RySS/ field staff to share their resources and responsibilities for the productive/ fruitful engagement with the farmers and for the rapid expansion of the program/ project.
b. Self-learning literatures, along with case studies, such as booklets, journals, pamphlets, etc, may be printed and distributed extensively and frequently.
c. All the television channels in the state may be encouraged and facilitated, under corporate social responsibility to cover APCNF program, food quality, health issues, etc.
d. Though APCNF predominantly is the Indian traditional agriculture model, it is now an alien model to most of the farmers, especially to the younger

generations. One of the suggestions received from the field is that “APCNF may be included in the school syllabus”. At present the mainstream agriculture research in the state and country is not focusing on APCNF. There is a need for the basic and action research on APCNF. The potential research topics include perfection and improvement of Kashayams and Asthrams; shade management in agro-forestry; combination of crops under mixed crops and agro-forestry in different local conditions; appropriate machinery and tools to manage the mixed cropping and agro-forestry; so on.