

Alternate cropping systems

for disposing multiple demands

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In India, there are more than 80 pre-dominant cropping systems. Continuous growing of existing pre-dominant cropping system has resulted in stagnation or decline in productivity, particularly in rice-wheat cropping system in Indo-Gangetic plains region. Excess use of inorganic fertilizers along with frequent use of pesticides and climate change have adversely affected soil health, productivity and thereby livelihood and nutritional security of small and marginal farmers. Hence, there is a need to develop site specific alternate cropping systems for efficient utilization of available resources, viz. land, water, solar energy etc and to maintain stability in the production systems for a longer period and get higher profit.

Keywords: Alternative cropping system, Predominant cropping systems, Rice equivalent yield, Water management, Weed management

INDIA is the vast and diversified country with a total geographical area of 328.7 mha, out of which nearly 139.4 mha is net sown area. The total food grain production has increased from 50.8 million tonnes in 1950–51 to 316.06 million tonnes in 2021–22. Owing to be of diverse climatic conditions, the country is highest producer of a huge variety of crops. The crops grown in India can be divided into four major categories, viz. food grains (rice, wheat, maize, millets and pulses), cash crops (cotton, jute, sugarcane, tobacco and oilseeds), plantation crops (tea, coffee, coconut and rubber crops) and horticulture crops (fruits and vegetables).

Cropping systems

Cropping system may be defined as the order in which the crops are cultivated on a piece of land over fixed period. The productivity of land is uphold or even increased through proper soil management practices. Cropping systems remain dynamic in time and space, making it difficult to

precisely determine their spread using conventional methods, over a large territory. As per estimate, more than 250 double cropping systems are being followed in the country. Based upon the rationale of spread crops in each district in country, 30 important cropping systems have been evaluated for the irrigated agro-ecosystem. Among them, major contributors to the national food basket are: rice-wheat (10.5 mha), rice-rice (5.9 mha) and coarse grain based cropping systems (10.8 mha). Rice and wheat together contribute to nearly 65% of the total food grain production, whereas rice-wheat system alone contributes

to 40%. Cropping systems of a particular region are being decided by taking soil types and climatic indices into consideration that on turn determine the overall agro-ecological setting for the nourishment and appropriateness of a crop for cultivation. At farmers' level, potential productivity and monetary benefits act as guiding principles while opting for a particular cropping system. The decisions in respect to choice of a particular crop or cropping systems are further closed down under several other factors available at micro level.



Radish (Bartender Mammoth)



Chickpea (Avrodh)



Cowpea (EC4216)



Mustard (RH725)

Identification of efficient cropping systems

The emergence of some of the second-generation problems such as over-mining of soil nutrients, decline in factor productivity, reduction in profitability, lowering of groundwater, soil salinization and resurgence of pests and diseases including weeds, diseases and insects during post-green revolution in most of intensively cultivated cereal based production systems threaten the sustainability of agriculture. To overcome these problems, various cropping systems and resource management techniques were adopted by duly taking care of region specific needs of crops and their cultivars. Various innovative alternative cropping systems have been identified and listed in Table 1.

The multiple cropping system as suggested, included both sequential and intercropping systems with inclusion of several variants such as mixed cropping, relay cropping, alley cropping, parallel multiple cropping, multi-storied cropping etc. Sequential cropping with inclusion of non-conventional crops, short duration crop cultivars and intensive input management practices are being observed as key factors in increasing productivity and profitability of the systems all over the country. By virtue of following a diversified system, viz. rice-garlic-maize cropping system, the productivity of rice-wheat system earlier observed to be of 5.8 tonnes/ha went as high as 508.9 tonnes/ha of

rice equivalent yield. Thus, adoption of proper diversification and improved production techniques offers a scope of achieving net income of 2.17 lakhs/ha with a high B:C ratio of 5.34.

Presently, the efficient alternative cropping systems have successfully been developed for different agro-climatic zones of the country to get high productivity. The present mean productivity of most suited prevailing systems stood at 9.2 tonnes/ha across the locations, which can be increased further up to the extent of 16.9 tonnes/ha via demo of high productive systems.

Weed management

The crops, those develop fast canopy and possess allelopathic properties generally impose an adverse impact on weeds infestation therefore, can be adopted as weed management tool. As per various estimations, in rice-rice system, nearly 31.5% reduction in system productivity was seen due to uncontrolled weed infestation. It was observed that growing of summer cowpea in soybean-wheat

system was effective in reducing weed population therefore, this practice is profitable in increasing the net income from the system. Concomitant increase in weed smothering efficiency occurs in intercropping of dhaincha+direct seeded rice and the system recorded 62% less density of weeds as compare to sole rice crop. Both direct seeded rice and wheat may be grown in tillage getting higher weed control and productivity and profitability of the rice-wheat system under irrigated conditions. Application of FYM @10 tonnes/ha before the ploughing with irrigation up to field capacity was effective in reducing weed infestation, release of nutrients and improved the productivity of sunflower-bell pepper sequence. Weed management through cover crops, intercrops, relay cropping are best cultural strategies for control of weeds.

Water management

For intensification of crops, irrigation is a commonly used platform. For sustainable intensification, more crops as well



Amaranthus (Arka Samraksha)



Sunflower (KBSH-1)

Table 1. Rice equivalent yield of alternative cropping systems and their economic returns under different agro-climatic regions of India

Agro-climatic zone	Alternate cropping systems	REY (tonnes/ha)	Yield increased over prevailing cropping system (%)	*Net returns (₹/ha)
Western Himalayan	Rice-marigold-french bean	30.10	166.37	335980
	Rice-potato-onion	29.50	164.02	296996
	Rice-cabbage-onion	24.20	158.72	262586
Eastern Himalayan	Winter rice-onion-cowpea(F)	23.15	142.68	247835
Trans Gangetic Plains	Maize-potato-onion	27.86	110.42	250046
Upper Gangetic Plains	Dhaincha-potato-okra	24.31	96.83	227450
Middle Gangetic Plains	Rice-potato-green gram	23.54	78.46	198578
Lower Gangetic Plains	Rice-potato-jute	25.53	88.65	215460
Eastern Plateau and Hills	Rice-wheat+potato-green gram	27.62	178.42	249366
Central Plateau and Hills	Soybean-wheat	18.73	75.14	186480
Western Plateau and Hills	Pearl millet-chickpea	16.46	66.37	145804
Southern Plateau Hills	Rice-rice	8.41	62.47	106784
East Coast Plains and Hills	Rice-groundnut-sesame	13.67	84.54	237650
Western Plains and Ghats	Rice-rice-cowpea (vegetable)	12.54	94.87	215768
Gujarat Plains and Hills	Paddy-onion-cowpea(F)	25.72	99.74	217749
Western Dry	Cluster bean-wheat	10.25	64.12	145268
Island	Rice-rice fallow	8.21	55.72	132430

*Net returns were calculated based upon the current market prices (2021–22)

as the profit per drop of water approach should be adopted and is only possible via carefully designing of the cropping systems. Water productivity can be increased to 59.7 kg/ha cm of water through maize+tomato+garden pea+french bean relay intercropping systems. The concept of complementary intensive intercropping systems, seeks raising of morphologically and physiologically different crops in an agricultural year under the sequential intercropping systems having the complementarities among themselves, and succeeding associations.

Nutrient management

Nutrient management planning offers us a systematic process to determine the amounts of nutrients needed for ideal plant growth. Any nutrients application operation that applies to land should have a nutrient-management plan prepared by an individual with a sound understanding of plant and soil sciences. There are many steps to follow when developing a nutrient management plan; however, the details involved with each step depend on the type of operation. It is important to remember that, for normal growth and development, plants must acquire nutrients from soils through root uptake. Therefore, if soil testing indicates a need for nutrients, then nutrients

must be added to the soil to support optimum plant growth. However, if too much nutrient is applied to land, these excess nutrients can leak from soils resulting in poor underground water-quality. Therefore, the overall aim of sound nutrient management is to optimize the plant health by duly taking care of environmental aspects.

Economics analysis of cropping systems

Delineation of agro-climatic zones based on soil, water, rainfall, temperature etc is considered as the first essential step for sustainable production. The predominant cropping systems were identified based upon the agro-climatic regions. The productivity in terms of rice equivalent yield (REY) was realised highest in western Himalayan region with rice-marigold-french bean (30.10 tonnes/ha) and least (8.21 tonnes/ha) was observed in the rice-rice fellow system under the Island region. The extent of increase in yield varied from 178.42% higher at rice-wheat+potato (1:1)-green gram cropping system to 55.72% higher in rice-rice-fellow system. Correspondingly, the net profits were highest with rice-marigold-potato and rice-potato-onion cropping systems (₹335980/ha and ₹296996/ha), respectively. Whereas, the minimum net profit (₹132430/ha) was obtained with the

rice-rice-fallow cropping system in Island region.

SUMMARY

Climate resilient and more remunerative cropping systems have to be developed for making country self-sufficient in food grain production based on available limited farm resources, viz. land, labour, capital and infrastructure etc. The productivity of prominent cropping systems can be increased many times by adoption of alternative cropping systems. This can be done by inclusion of new crops in prevailing cropping systems of different agro-climatic zones (ACZs). Newly identified efficient cropping systems revealed to add additional productivity and profitability to farmers' for which short-duration cash and catch crops can be integrated easily with long duration crops in between two crops and seasons. Thus, novel selected crops were found more suitable to prevailing climate, soil, irrigation, market, input supply, labour availability and better farmers' perception to adopt them. The developed cropping systems need to showcase in farmers fields to break the traditional systems which are vulnerable to climate variability.

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