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Strip cropping: A solution for declining intercropping in India

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Strip cropping offers a promising solution by allowing mechanised, single-operation sowing of crop strips wide enough for independent management yet narrow enough to retain beneficial crop interactions. Field studies at ICAR-CRIDA proved that 4:4 sorghum + pigeonpea strip configuration using a customised planter sown in a single operation improved yield of the total system up to 22–43% during high rainfall years, reduced labour and energy requirement, improved land use efficiency, crop intensification and crop diversification opportunities compared to conventional 2:1 sorghum + pigeonpea intercropping. Strip cropping emerged as a sustainable, climate-resilient cropping strategy suited for both smallholders and commercial farms in India due to improved soil water retention, light interception, supporting soil health, and provides ecosystem services such as erosion control.

Keywords: Climate adaptation, Herbicide, Light interception, Mechanisation, Single operation

IN the scenario of global environmental concerns like scarce resources and climate change, intercropping has regained prominence as an adaptation strategy for India's rainfed eco-systems. In the event of present-day climate variability, shifting rainfall pattern, extreme weather events and rising temperatures, strip cropping offers advantages. Strip cropping though widely practiced worldwide, has not been picked up in India due to the non-availability of appropriate implement to sow both crop strips in a single instance. Traditionally, intercropping systems in India are cereal and pulse combination based, however, strip cropping has its own benefits. It promotes resource conservation (soil, water and nutrients) by minimising soil erosion, fostering land degradation neutrality and enhancing root zone soil moisture. Beyond these environmental benefits, agronomic advantages of improved land use efficiency through crop intensification and diversification also could be gained. In order to encourage adoption of strip cropping, researchers tried to customise the implement for strip crop sowing in a single-pass, hence conducted field experiments to validate its suitability and flexibility.

Limitations in adopting intercropping systems

The traditional intercropping systems though have its ecological and agronomic advantages, but have not been extensively adopted by the farmers in modern Indian agriculture. These systems include cereal/millet with pulse crop combination in various row ratios and these require herbicides and pesticides individually which often causes the phytotoxicity in the component crops due to its proximity with drift reducing plant population. Mechanical operations such as pesticide sprays are other problems farmers face. Mechanical requirements are critical for farmers where resources are already constrained. Labour scarcity, lack of training and maintenance in mechanisation has further aggravated the problem that could otherwise support more efficient intercropping practices. Hence, there is decline in the area under intercropping systems.

Experiments in ICAR-CRIDA

Field experiments conducted for five years on 4:4 strip cropping of sorghum and pigeonpea (replacement series) at ICAR-Central Research Institute for Dryland Agriculture (CRIDA) research farm. To explain it further, strip cropping is also one form of intercropping wherein the sorghum crop strip is sown as 4 rows alternating with 4 rows of pigeonpea crop strip, the strip narrow enough to interact agronomically and sufficiently wider for mechanisation. However, traditional intercropping refers to growing two or more than two crops in various row combinations.

The point of concern is sowing of more than one crop in a single operation' is not met, hence the disinterest of the farmers. To address this concern, we customised a nine-row planter with a 2.7 m toolbar to

sow both crops simultaneously. The design positions two sorghum rows on one side and two pigeonpea rows on the other, adhering to the standard 45 cm × 15 cm and 90 cm × 20 cm spacings, respectively. Mechanical markers are set at half the crop spacing on both ends of the row bar to ensure precision tracking and spacing of the next row. On reaching the field head, a turn and a return pass of the tractor again sow the remaining two rows of each crop. This operational sequence establishes a standard 4:4 strip intercropping architecture. This ensures single-pass establishment of both crop components. However, customisation of the implement for the required strip cropping helped in not only labour (10%) and money saving but also ease in management of weeds, pests and diseases for different component crops mechanically or chemically.

Implement customised for 4:4 sorghum and pigeonpea strip crop sowing

Advantages of strip cropping

Altered configuration of traditional 2:1 sorghum and pigeonpea intercropping system transformed into 4:4 strip cropping provided 22–43% improved total system yields for the extended monsoon year. Increased yields earned additional net return of ₹14,910–21,000 per ha with an advantage of providing food security of both cereal and pulse needs of the family of five for 81–87 days and for 415–565 days, respectively. This was calculated as per the guidelines of ICMR-National Institute of Nutrition (NIN) to 2 kg cereal and 400 g of pulses per day. In addition, the B:C ratio increased from 2.14 of conventional intercropping to 2.88–3.14 of strip intercropping. The spatial arrangement of 4:4 strips reduced interspecific competition, improved light interception, aeration, and photosynthetic efficiency among component crops. Improved pigeonpea yields could also be attributed to increased number of branches by 8–10% over 10–12 branches of the pigeonpea crop plant in 2:1 intercropping of sorghum and pigeonpea. The above observation on branching increased the number of flowering branches, in turn pods and seed yields. Most of the years, pigeonpea as the commercial crop influenced the dynamics in income generation. Hence, the field studies and farmer trials have demonstrated that strip cropping due to its variable crop geometry can result in higher yield encasing in on the extra rains depending upon the rainfall scenario. Its performance was comparable with the traditional recommended 2:1 intercropping of sorghum and pigeonpea in rainfed SAT Alfisols for all types of rainfall i.e. normal rainfall of 760 mm, deficit rainfall and extended monsoon rainfall as well.

Field of strip cropping

Besides, ease in spraying herbicides like pendimethalin @ 0.75 – 1.0 kg/ha or metolachlor @ 1–2 kg a.i./ha as a pre-emergence (reducing phytotoxicity) pesticide sprays to pigeonpea crop was facilitated from the harvested sorghum strip space. Opportunity of sequence cropping of horsegram was also experimented in those strips to improve the cropping intensity. In short, strip cropping is a great step towards crop intensification and crop diversification strategy for the changing climate due to its accommodating potential of a greater number of crops.

Further, strip cropping can also enhance resource use efficiency viz. rainwater retention by 2–3% and enhanced light interception by 35–40% with aerial space availability due to changed crop geometry. Different crop species occupy different layers of the soil and canopy levels, reducing competition and maximising resource utilisation.

Table 1. Advantages of 4:4 strip cropping of sorghum and pigeonpea over recommended 2:1 intercropping of sorghum and pigeonpea

Rainfall situation	Yield advantage (%) of strip cropping over 2:1 intercropping	Increased % net returns in strip cropping over 2:1 intercropping	Labour saving in strip cropping over 2:1 intercropping (%)	Crop intensification possibility in strip cropping over 2:1 intercropping	Crop diversification possibility in strip cropping over 2:1 intercropping
Normal rainfall year	8–9	20	10	Additional one to two crops	3–4 crops over 2–3 crops in 2:1 intercropping
Deficit rainfall year	No advantage (Both performed at par)	0	10	Additional one to two crops	Same as above
High rainfall year	22–43	66	10	Additional one to two crops	Same as above
Food security days	Food security of both cereal and pulse needs of the family of five for 81–87 days and for 415–565 days (ICMR-NIN)				

Strip cropping of sorghum and pigeonpea in the farmer field of Choudarpally village, Rangareddy Distt., Telangana

Strip cropping also offers multiple ecosystem services. It helps improve soil structure and health by allowing rotation of strips with different crop families across seasons, thereby breaking pest cycles and balancing nutrition. Crops with deep roots stabilise the soil, while closely spaced ground cover crops reduce surface runoff. In sloped terrains, contour-aligned strips act as physical barriers, slowing down water flow and capturing sediments, thereby preventing land degradation to the permissible limits only (4 t/ha).

Strip cropping in India

Each strip consists of multiple rows of crops either of same or different species or genera. Depending upon the maturity, duration and growing season of component crops planted, management and harvesting can be done independently or concurrently adding flexibility without compromising efficiency. Even though the concept is available since long world wide, it is not popular in India. Our survey showed that the research on strip cropping was not updated for sowing more than one crop strip in a single operation. Strip crop sowing in more than one operation is burdensome for farmers in terms of time, effort and money. Non-availability of suitable implements for single-pass sowing of different crop strips and the lack of appropriate customisation is the challenge. As mentioned earlier, customisation of implement for single pass sowing of two different crops and availability of nine row planter through custom hiring centres make it farmer friendly and enhance the interests of farmers.

Challenges in implementation and way forward

Even though strip cropping is considered as more efficient than traditional systems, it is having certain challenges that need optimisation. Determining the optimum strip width that balances interspecific interactions with mechanisation is critical. Narrow strips promote ecological interactions but hinder machine access, whereas wider strips allow easy mechanisation but may limit the complementary benefits of intercropping. In order to save time, fuel, and labour for sowing, existing implements must be customised according to the need of the farmers while they must be trained to use these implements. Strip cropping can be promoted among both large and smallholder farmers with the help of appropriate extension tools like custom hiring centres.

To address these concerns, strip cropping systems must be developed through participatory research, tailored to location specific conditions. Long-term trials and extension support can help farmers adapt to this system gradually. With investment in suitable machinery or customisation of existing machinery, and access to proper training, strip cropping can become a profit-making practice in a sustainable mode.

SUMMARY

As Indian agriculture is threatened by shrinking arable land, climate variability, land degradation and labour shortages, it is imperative to redesign the existing intercropping systems. Strip cropping as a climate adaptive strategy bridges the gap between ecological sustainability and agronomic efficiency. By offering operational flexibility, it promotes intensive, resilient, and profitable land use while easily integrating with mechanisation and modern management practices.

This technology would empower both smallholders (as the custom hiring centres can be a perfect conduit for access to such implements) and large-scale farmers alike. With the right support, such as training the tractor operators or the rural youth, this system has the potential to transform Indian agriculture. Further strip cropping not only supports crop intensification by introducing relay or sequence crops but also encourage crop diversification as a sustainable climate resilient cropping system. Therefore, strip cropping can be viewed not just as an alternative, but as the future intercropping system in India.

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