NITROGEN-FIXING COVERCROPS FOR CALIFORNIA RICE PRODUCTION

Funded by the California Energy Commission and the Rice Research Board

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by
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University of California Cooperative Extension

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INTRODUCTION

Before synthetic nitrogen fertilizers were widely available, many rice farmers grew vetch and other leguminous green manure crops as a means of supplying nitrogen to the rice crop. In the 1950s, green manuring was practiced on about one-fifth of the rice land in California (Williams et al., 1957). As fertilizer availability increased and price decreased, use of green manures declined.

Today, there is renewed interest among California's farmers in the use of covercrops for maintenance of soil quality. For rice growers, several technologies have improved the feasibility of covercropping. Laser leveling of fields has improved winter drainage, creating better conditions for covercrop growth. Introduction of short-season rice cultivars has resulted in earlier harvest, providing more time to prepare the covercrop seedbed than in the past.

However, as open-field burning of rice straw is being phased out, there are questions about the compatibility of covercropping with straw incorporation.

The purpose of this bulletin is to describe benefits and limitations of covercropping in rice rotations and the appropriate cultural practices. Results from three rice-covercropping field experiments are also presented. Information in this bulletin is based in part on recent field research but is also derived from two earlier UC publications, *Green Manures and Crop Residues in Managing Rice Soils* (Williams et al., 1957) and *Covercrops for California Agriculture* (Miller et al., 1989).

BENEFITS AND LIMITATIONS OF COVERCROPPING IN A RICE ROTATION

Winter covercropping in a rice rotation takes advantage of an unused window in the crop calendar to add organic matter and nitrogen to the soil. The value of doing so must be weighed against the cost of covercropping and the extra time required to allow for growth of the covercrop in the spring. Several benefits and limitations are discussed here.

Nitrogen Contribution

Leguminous covercrops such as purple vetch can make a significant nitrogen contribution to the following rice crop, reducing and sometimes eliminating the need for synthetic N fertilizer. This is due to the biological fixation of atmospheric N by bacteria in nodules on the roots of most legumes. Furthermore, both legume and non-legume covercrops will take up N from the soil that would otherwise be lost by leaching or denitrification (conversion to N gases) during the Sacramento Valley's wet winters. In field experiments conducted in Butte and Sutter counties, covercropping with vetch has reduced the rice fertilizer N requirement by 30 to 100 lb N/acre, with an average over several experiments of about 50 lb N/acre. By estimating covercrop N content shortly before incorporation, a rice grower can adjust the rate of N fertilizer in response to year-to-year variations in covercrop growth. See the **Cultural Practices** section for a simple method for estimating covercrop N content. Covercrops contribute N primarily to the following rice crop. A small amount of residual N -- too little to be readily measured in field experiments -- will become available to rice crops in succeeding years.

Rice Yield Improvements

In some experiments in the Sacramento Valley, maximum rice grain yields have been several hundred pounds per acre higher on covercropped plots than on non-covercropped plots. Additional N fertilizer applied to the non-covercropped rice before planting did not make up the difference. No explanation for this higher yield was apparent, and it occurred only on fields where straw was burned in the fall rather than incorporated into the soil. The higher yield did not appear to be the result of a covercrop effect on disease, insects, or soil tilth. Rice leaf N levels suggested that the yield difference may have been due to the improved timing of N supply where a covercrop was grown. See further discussion in the **Case Studies** section.

Other Impacts

Soil Tilth. Incorporation of covercrops, animal manures, or other organic amendments, can improve soil tilth by lowering bulk density and converting the structure of the soil from massive to granular. In heavy-textured soils, this takes many years and large quantities of added organic matter. No long-term studies of soil tilth in rice systems have been conducted. The benefit of any such improvement in a rice rotation would likely be to non-rice crops. However, some rice growers claim that incorporation of covercrops has reduced the energy required for tillage. At the Sills Farm experiment in Sutter County, measurements of the force required to pull a chisel through the soil in the spring after two years of covercropping and rice straw incorporation did not reveal any effect of purple vetch covercropping or straw incorporation. However, two years is probably not long enough to detect changes in tilth.

Rice Straw Breakdown and Soil Microbiological Activity. Covercropping increases soil organic matter and nitrogen, but it is not known whether this hastens breakdown of rice harvest residues. Some researchers have observed that covercropping increases the overall size and diversity of soil microbes. See the **Case Studies** section for further discussion.

Gas Production. A potentially detrimental effect of covercropping is enhancement of gas production. Additions of fresh organic matter to rice fields just before flooding can lead to increased production of methane, H_2S, or other organic byproducts of anaerobiosis. This can affect rice growth and development. However, in field experiments in California, covercropping has not had any apparent detrimental effects. Incorporation of both rice straw and leguminous covercrops increases methane emissions (Lauren et al., 1994), possibly contributing to global warming. However, a growing covercrop consumes carbon dioxide -- the most important greenhouse gas -- and reduces the need for nitrogen fertilizer, the manufacture of which consumes natural gas or electricity.

Rice Diseases. Covercropping has not been observed to affect the incidence or severity of diseases that are common in California rice fields. Both covercropped and non-covercropped plots at the Sills Farm experiment showed somewhat more stem rot where excessive N fertilizer was applied.

Delay in Planting Rice. Covercrop growth is usually very slow until mid- to late-March. To get maximum biological N fixation and production of covercrop biomass, purple vetch should be allowed to go to mid-bloom, which usually occurs in April. Lana woollypod vetch will bloom earlier than purple vetch. Beyond mid-bloom, little additional nitrogen will be biologically fixed. Most rice growers cannot wait until mid-April to begin working fields and will therefore be able to covercrop only a portion of the rice acreage. Water sowing of a covercrop before rice harvest can produce better fall growth than post-harvest sowing and may permit earlier incorporation the following spring. Water sowing is described in the **Cultural Practices** section. One other factor related to timing is the occurrence of late winter or early spring rains. A growing covercrop will dry out the soil and possibly allow equipment into the field sooner than if the field were left in bare fallow.

Economics and Energy Use

Economics of Covercropping. The main costs of covercropping are purchase of seed, preparation of the seedbed and planting. Seedbed preparation and incorporation requirements will vary greatly depending on soil type, soil moisture content, amount and distribution of rice harvest residues, and the amount of covercrop growth. Under the most optimistic scenario, no extra tillage will be required for covercrop seedbed preparation or incorporation of the covercrop biomass in the spring. Table 1 shows hypothetical costs and energy use for covercropping with purple vetch in a rice rotation. Seed cost may vary considerably from the values shown in Table 1, especially if a grower produces his or her own seed.

Table 1. Covercropping costs and energy use in a rice rotation.

Operation	$/acre	Million BTU/acre
Extra stubble discing for seedbed preparation[a]	8	0.56
Purple vetch seed, 40 lb @ $0.65/lb[b]	26	0.63
Aerial broadcast application	5	0.20
Roll after planting[a]	5	0.33
Re-open drains	1	- 0 -
Total	45	1.72
Off-farm energy in 50 lb fertilizer N		1.65

[a]In many cases, these operations would not be required.
[b]Price based on one supplier quote. Other prices: Lana vetch - $0.80; bell beans - $0.25; common vetch - $0.40.

The economic benefit of covercropping consists mainly of the fertilizer N replacement value. Fertilizer N replacement value in field experiments has ranged from less than 10 to over 100 lb N/acre with multi-year averages of 40 to 60 lbN/acre in different experiments. N fertilizer replacement value can be estimated by determining the covercrop N content (see **Cultural Practices**) and assuming that one pound of N in the covercrop will replace one pound of N as preplant fertilizer. Non-uniformity of covercrop growth will decrease the fertilizer value, because enough fertilizer must be applied for the rice in areas of the field with the poorest covercrop growth.

The cost figures shown in Table 1 indicate an unfavorable economic return on covercropping in rotation with rice, if one assumes a fertilizer N value of 20 to 30¢ per pound of fertilizer N and no long-term benefits. However, actual costs and benefits may vary greatly from the figures shown. Lower seeding rates, lower seed price or on-farm production of seed, better covercrop growth and N production, and elimination of the extra discing or rolling are factors that could make covercropping economical in some cases. Furthermore, vetch seed can be grown as a cash crop.

Some experiments in California have shown rice grain yield increases of about 200 to 300 lb/acre above what could be obtained with the optimal rate of preplant-applied N fertilizer in non-covercropped plots. Any such non-N effect would make the economics of covercropping much more attractive. See the **Case Studies** section.

For additional information on cost of rice production, see the two cost studies listed in the references. These are available from the Department of Agricultural and Resource Economics, University of California, Davis.

Energy Aspects of Covercropping. On-farm use of energy will increase with covercropping because additional energy will be used to plant and incorporate the covercrop (Table 1). This would be offset by any reduction in energy required for tillage due to improvements in soil tilth. The major off-farm energy cost in covercropping is the energy used to produce the seed.. On the other hand, off-farm energy use will drop by about 33,000 ~~kilocalories~~ BTUs per pound of fertilizer N saved, which approximates the energy cost of ammonia fertilizer manufacture and transport (Pimentel, 1992). Using a typical N fertilizer replacement value of 50 lb N/acre, off-farm energy savings would be 1,650,310 BTU/acre, equivalent to the energy in 9.6 gallons of diesel fuel.and similar in magnitude to the total energy (on-farm plus off-farm) used to produce the covercrop (Table 1).

CULTURAL PRACTICES

Establishing a covercrop following rice can be difficult. The combination of wet, heavy soils and uncertain weather can lead to plugged discs and half-finished fields. But most years, an adequate stand can be established that will produce a significant amount of N and organic matter for the soil. There are several ways to grow vetch or other covercrop species, giving the grower some flexibility to deal with soil and weather difficulties.

Cover Crop Rotations

Rice growers have used covercrops in their rice rotations in several ways:

1. In continuous rice: Plant the covercrop in the fall after rice harvest and following straw incorporation or burning. Incorporate the covercrop in the early spring as part of seedbed preparation. Covercropping in a continuous rice rotation is not a common practice because of the limited time and wet soil conditions, but it can work in some years and on lighter soils.
2. In a two-year rice-fallow rotation: Plant the covercrop immediately after rice harvest and following straw incorporation or burning, then let it go to seed in the spring. This will produce a volunteer crop the following fall.
3. In a two-year rice-fallow rotation: Plant the covercrop one year after rice harvest. Seeding the covercrop the year after fallowing allows time for straw incorporation and decomposition and results in a better seedbed for the covercrop.
4. Broadcast the seed in the water before harvest just as the field is beginning to drain. Water sowing is the traditional method of planting a green manure crop in rice and sometimes can produce much better establishment and growth than later planting dates. However, it is not compatible with fall burning or incorporation of rice straw.

Selecting Covercrop Species

Covercrop species suited for rice production in California are described in *Covercrops for California Agriculture* (Miller et al., 1989). The best covercrop species for rice are purple vetch, woollypod vetch, and fava bean (bell bean). The vetches will grow during the coldest months of the year. They are relatively tolerant of wet conditions in the early winter and will produce well if there is a drying period in March and April.

Purple Vetch. Purple vetch, *Vicia benghalensis,* is the most commonly used species for covercropping in rice. It is a viny species and is markedly hairy or pubescent overall. It can survive 20°F temperatures. Purple vetch produces slightly later in the spring than woollypod vetch so is probably a better choice for heavy rice soils.

Woollypod (Lana) Vetch. Woollypod vetch, *Vicia dasycarpa,* may be a good choice for lighter soils or where the covercrop must be incorporated earlier in the spring. The Lana cultivar is the most recently introduced variety that is successful in California. It resembles hairy vetch (*V. villosa*) and is more prostrate than purple vetch. It flowers about three weeks earlier than purple vetch and is somewhat more winter hardy. Lana vetch is not as tolerant of saturated soil conditions as purple vetch or bell beans.

Bell bean. Bell bean, *Vicia faba,* is a small-seeded fava bean. Its growth habit differs from purple and woollypod vetch. It has coarse, erect, succulent stems, a large taproot, and larger leaflets and seeds than the other vetches grown in California. It is similar in adaptation to purple and Lana vetch but is more sensitive to low temperature. It is more tolerant of flooding than Lana vetch. Under good conditions, it can outproduce purple vetch but has not been used much by rice growers. (see **Case Study 2**).

Seedbed Preparation

Before a covercrop is planted, rice harvest residue should be chopped, disced, or rolled so that it is in close contact with the soil. Straw on the surface can be tolerated if it is uniformly distributed, but the covercrop will not become established where thick straw rows are left on the surface.

If weather permits, discing the straw residue and then broadcasting the covercrop seed is effective. Fall discing incorporates the straw, making less work in the spring and allowing for better contact of the seed with the soil. Usually one or two passes with a stubble disc is required. A smooth, soft soil surface is neither required nor desirable. Plowing often does not produce a good seedbed for covercropping, because it will bury the rice harvest residues in a layer. Decomposition of the residue in this layer under saturated, wet winter conditions can lead to production of phytotoxic compounds.

Winter drainage is essential for a healthy covercrop. Saturated soil conditions in the winter will result in a poor stand or will drown plants that have already become established. If possible, rice checks should be left open and borrow ditches and pits left intact. Drains should be put in where needed.

Planting the Covercrop

Broadcast Seeding. Seed should be broadcast by air or ground rig then covered using a disc or rice roller. The roller does a good job if the clods will crumble and cover the seed and will leave the soil smoother for spring field work. In many cases, an adequate stand of purple or Lana vetch (but not bell beans) can be obtained with no post-seeding tillage. Purple or Lana vetch can be planted where the soil surface is covered with rice straw. Seed is round and will bounce and roll down onto the soil surface. Stubble will protect seedlings and provide a scaffolding for seedlings to climb.

Direct Drilling. When soil conditions are dry enough, direct drilling of the covercrop seed through the stubble will produce good seed-soil contact. Usually, a conventional drill is not heavy enough to cut through rice straw, and a heavier, no-till drill is needed. Rice harvest with a stripper header or use of a good straw spreader will reduce the thickness of straw windrows, making the seedbed more suitable for direct drilling.

Water Sowing. For water sowing before rice harvest, seed should be broadcast from two days before to two days after water is drained from the field. This method works best in late-planted fields that are drained in mid- to late-September. Vetch will grow well if rains come shortly after harvest. In fields that are drained in August or early September, there is the risk that the vetch will die from drought before the first fall rains. At harvest, the combine cutter bar should be set high enough to leave 6 to 12 inches of the covercrop plants intact. Straw windrows left by the harvester can smother or kill young plants, so it is important to spread the straw. Water sowing is not appropriate for bell beans.

Seeding Rate

It is important to minimize the seeding rate, as seed is the main expense of covercropping. Recommended ranges of seeding rates in lb/acre are:

Purple vetch	40 - 60
Woollypod vetch	40 - 65
Bell beans	125 -175

The lower end of the range is recommended for broadcast seeding before November 15 for seedbeds in good condition. Later planting and poorer seedbed condition justify higher seeding rates. Seeding rates as low as 25 lb/acre for purple vetch have been used where seedbed conditions are ideal. This might be adequate where one or more of the following factors are present: Longer rotations, re-leveling of fields after harvest and before planting of covercrop, straw removed by burning or baling, thorough rice straw incorporation, or drill seeding.

Fertilization

Legumes generally respond well to phosphorus and sulfate fertilizers and -- on soils with pH below 5.5 -- to lime additions. P deficiency is commonly seen in crops rotated with rice such as safflower and wheat. This is due to the rapid reversion of soluble phosphate to insoluble, highly unavailable forms of P following drainage of rice fields. P deficiency in covercrop legumes can be diagnosed by visual symptoms and plant tissue analysis. P-deficient legumes grow slowly, develop dark or dull green foliage, and in some cases may develop a reddish tinge. Tissue P concentrations of less than 0.15 - 0.20% (total P) may indicate P deficiency. Soil analysis is not reliable for diagnosing P deficiency in a rice rotation.

The cost of phosphate fertilizer could well make covercropping uneconomical. Growers should consider several alternatives. If P fertilizer is already normally applied during the rice seedbed preparation, consider applying it in the fall in order to provide benefit to the covercrop. If the covercrop is drill planted, phosphate fertilizer can be applied through the drill, and a much lower rate (20 to 40 lb P_2O_5/acre) will be required than with broadcast application. On acid soils, phosphate fertilizer plus lime will produce a better response than fertilizer alone. Waste sugarbeet lime is an ideal liming material for this situation, because it contains some plant-available P.

Inoculation with Nitrogen-fixing Bacteria

If a field has not been covercropped with a legume for a long time, the covercrop seeds should be treated with a commercial inoculant prepared by a reputable laboratory. The inoculant specific to the crop being planted must be used. Do not purchase inoculant long before you plan to use it. Do store it under refrigeration. If the same legume is grown on the land repeatedly and at short intervals for several years, the bacterial population will build up in the soil such that further seed inoculation may not be needed. For more information, see UC Bulletin 1842 (Phillips and Williams, 1987).

Incorporation of Covercrops

Covercrops are usually incorporated by discing as a normal part of rice seedbed preparation. In some years when unusually good growth occurs, it may be hard to disc the material down due to large biomass and tough stems. If such a problem occurs, the covercrop can be flail chopped, then immediately incorporated. Waiting even a couple of days after chopping may make it more difficult to incorporate the material.

Estimating the Nitrogen Contribution of Covercrops

The total amount of N in the covercrop at the time of incorporation can be estimated from the fresh weight of the above-ground plant material.

1. Cut and weigh the fresh covercrop from a 16 square foot (4 ft x 4 ft) area.
2. Multiply the fresh weight in pounds by a factor to estimate the pounds of nitrogen per acre contained in the covercrop. Factors are: Vetch - 16; bell beans - 10; berseem clover - 13.
3. Repeat this sampling 5 to 10 times over the field, depending on its uniformity. Average the results. Samples should be free of dew.

For example, if you harvest 5 pounds fresh weight of vetch from a 4 ft x 4 ft area, you know there are approximately 80 lb/acre of covercrop N (5 x 16=80). The multiplication factors apply to a wide range of growth stages. As the covercrop approaches maturity, N content lessens but dry matter percentage increases. Thus the factors remain stable with advancing maturity.

This procedure estimates N in the above-ground covercrop biomass. This is not the same as fertilizer equivalent (or replacement) value. Some field studies have shown that one pound of covercrop N replaces more than one pound of fertilizer N. See the **Case Studies** section below.

CASE STUDIES IN THE SACRAMENTO VALLEY

Case 1. Sutter County -- Sills Farms Experiment

In a five-year field experiment on a loam soil in Sutter Co., researchers measured the above-ground N content of purple vetch shortly before incorporation in late April each year. Covercrop growth varied from year to year with amount of rain and success in stand establishment. In one year (1993), extremely wet, saturated soil conditions in the late winter and early spring almost completely suppressed covercrop growth, even though an adequate stand had been established. In the other years, N content of the above-ground biomass ranged from 34 to 105 lb N/acre. Including all five years, N content averaged 49 lb N/acre in fall-burned plots and 39 lb N/acre in fall-disced plots (Table 2). In the final year of the experiment, vetch plants exhibited P deficiency. Low soil pH (4.5 - 5.0) contributed to that problem.

Table 2. Purple vetch N content and equivalent fertilizer N value in a continuous rice rotation.

	Straw burned in fall		Straw disced in fall	
Rice crop year	Vetch N content	N fertilizer replacement	Vetch N content	N fertilizer replacement
	lb N/acre			
1990	38	74	16	88
1991	105	108	86	90
1992	57	90	47	60
1993	6	0	10	0
1994	37	70	34	60
5-yr average	49	68	39	60

Data from Sills Farm, Sutter Co. (Rice Research Board annual reports, Project RM-6, 1990-94)

Excluding 1993 data, the fertilizer N replacement value of vetch ranged from 60 to 108 lb N/acre with each pound of N in the vetch above-ground biomass tops replacing 1.4 to 1.5 lb of fertilizer N. Equivalency of vetch N to 100% or more of fertilizer N has been reported by others in California (Case Study 2 and Williams et al., 1968). However, lower fertilizer N equivalencies have also been reported (Williams et al., 1972 described in Case Study 3 below). Possibly in some cases, covercrop N is supplied to rice plants more efficiently than synthetic fertilizer N applied shortly before flooding. The explanation given by some researchers for this relatively greater efficacy of covercrop N is that temporary immobilization of inorganic N during initial stages of decomposition before flooding minimizes losses from denitrification and volatilization (Huang and Broadbent, 1989).

Also, after five years, the top foot of soil on covercropped plots contained about seven percent more organic matter and total nitrogen than the non-covercropped plots. This occurred even though in four of the five years, the non-covercropped plots received nitrogen fertilizer and the covercropped plots did not.

Rice grain yields at the Sills Farms experiment showed a strong nitrogen response. On the straw-burned plots,there appeared to be a non-nitrogen effect. Grain yields on the covercropped plots at the optimal fertilizer N rate exceeded maximum yields on the non-covercropped plots (Figure 1). The yield advantage was small but occurred in four of the five years.

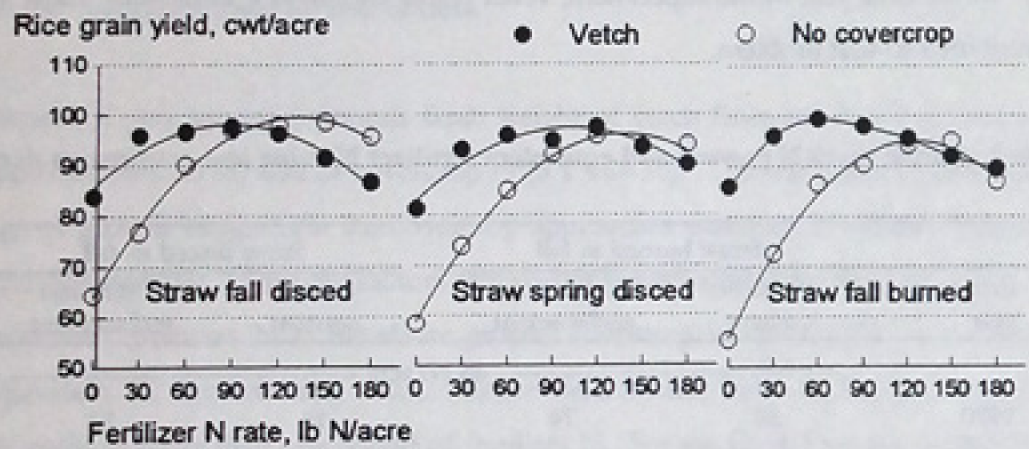

Figure 1. Five-year average yields as influenced by covercropping and rice straw management at the Sills Farms experiment in Sutter County, 1990-94. Straw management and covercropping treatments were repeated annually on the same 0.5-acre plots with six replicates.

Straw breakdown and microbial diversity. After five years, researchers observed faster rice straw breakdown in plots that had a history of rice straw incorporation compared to those where straw had been burned every year (Figure 2). Results indicated that rice straw incorporation, and to a lesser extent covercropping with vetch, enhanced the overall size and diversity of soil microbes (Table 3; and Bossio and Scow, 1995). Although the effects were small, some effect persisted year round and did change straw decomposition rates in the field.

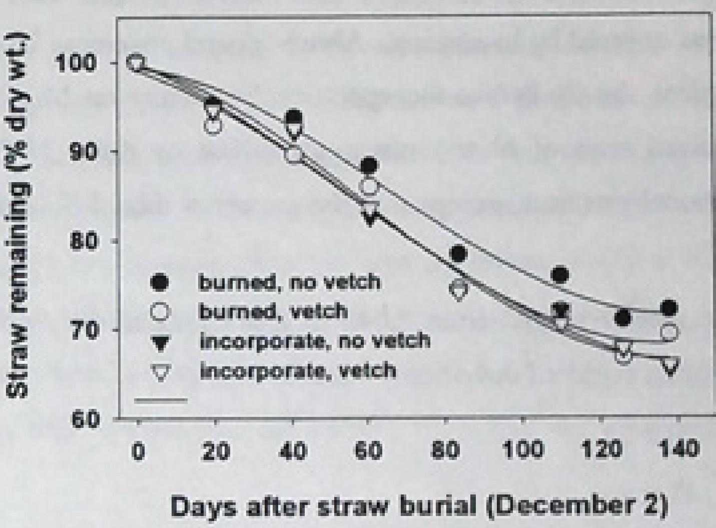

Figure 2. Effect of covercropping and rice straw disposal method on disappearance of straw buried in nylon mesh bags (Unpublished data, D. Bossio). Rice straw disposal methods and covercropping had been in effect for five years before bags were buried.

Table 3. Effect of covercropping with purple vetch and rice straw management method on soil microbial substrate-induced-respiration. Covercropping and straw treatments had been in effect for five years before measurement was made (Unpublished data, D. Bossio. For description of methods, see Bossio and Scow, 1995).

Straw/covercrop practice	March 22	April 19
	------------$\mu g\ CO_2\ g^{-1}$ soil hr^{-1}	---------------
Straw burned		
Vetch covercrop	4.29 bc	2.49 a
No covercrop	3.12 c	2.81 a
Straw spring-incorporated		
Vetch covercrop	6.66 a	3.09 a
No covercrop	4.88 b	3.11 a

Values followed by the same letter in a column are not significantly different at the 5% level of significance.

Case 2. Butte County -- Skinner Ranch

A one-year on-farm experiment was conducted in 1989 in Butte County on a clay soil. The field had been burned and disced. Covercrop species were broadcast seeded in mid-October, 1988, on plots replicated six times. Rates of seeding were: Bell bean - 150 lb/acre, purple vetch - 40 lb/acre, Lana vetch - 30 lb/acre. Seed was covered by harrowing. Above-ground covercrop biomass and N content were measured on subplots shortly before incorporation by discing on May 3. Subplots within each covercrop plot received rates of N as ammonium sulfate by drill. M-201 rice was planted and grown with conventional practices, except that the grower withheld N fertilizer on the experiment area.

Biomass yields for the three species ranged from 2,046 to 2,685 lb/acre dry matter. Above-ground N contents in lb N/acre (with standard deviations) were:

Purple vetch	70 ±20
Lana vetch	47 ± 6
Bell bean	59 ±10

With no covercrop, grain yields were maximized with 60 lb N/acre (Table 3). On all covercropped plots, grain yield was maximized with no fertilizer N. Thus, the three covercrop species provided N equivalent to about 60 lb N/acre of fertilizer. As in the Sills Farm experiment (Case Study 1), fertilizer replacement value of the covercrop was close to or above 100% of the aboveground N content. For all treatments, rates of N fertilizer above the optimum reduced yield due to lodging and possibly blanking. Maximum yields on covercropped plots appeared to be 2 to 5 cwt/acre higher than the maximum yield on the non-covercropped plots. Rice yields did not differ among the three covercrop species.

Table 3. Effect of covercropping on rice grain N response in Butte Co., Skinner Ranch, 1989.

N fertilizer rate	No covercrop	Purple vetch	Lana vetch	Bell bean
lb N/acre	---grain yield, cwt/acre, 13% moisture---			
0	67.6	82.8	80.2	83.3
30	73.2	78.1	76.7	79.7
60	78.2	67.2	73.5	77.6
90	70.4	63.1	52.7	59.2

Covercrop treatment means LSD.05 = 2.9 cwt/acre; within N=0 treatment LSD.05 = 7.9 cwt. Maximum yields for each covercrop treatment are highlighted.

Case 3. Butte County -- Rice Experiment Station (Williams et. al, 1972)

A five-year field experiment was conducted at the Rice Experiment Station in Biggs on a Stockton clay soil to compare straw incorporation methods and to determine the effect of covercropping with purple vetch. Subplots were fertilized annually with 0, 40, 80, and 120 lb N/acre as ammonium sulfate drill applied. Five-year average grain yields showed no measurable difference between rice straw burning and incorporation at any level of fertilizer or vetch N. Vetch covercropping had a positive effect on yield equivalent to about 40 lb N/acre (Table 4). The effect was similar on straw-burned and straw-incorporated plots (not shown). The researchers did not report purple vetch seeding rate, planting method, or vetch biomass and N production. Generally, vetch grew poorly and supplied only about 25% of the N needs of the rice crop.

Table 4. Effect of covercropping with purple vetch on rice grain yield averaged over five years and across straw-burned and straw-incorporated treatments.

N applied to rice	Purple vetch	No covercrop
lb/acre	-------- cwt/acre, 14% moisture ---------	
0	43	27
40	51	41
80	**56**	52
120	54	**57**

Maximum yields for each treatment are highlighted.

SUMMARY

Covercropping with nitrogen-fixing crops in a rice rotation can, under optimal conditions, provide nitrogen economically to the following rice crop. Covercrop biomass N is used by rice as efficiently – and in some cases more efficiently – than pre-plant fertilizer N. The N fertilizer value of a covercrop can be estimated by a grower at the time of covercrop incorporation in the spring by determining the fresh weight of the covercrop growing in a small area. Covercrops can be established in most years under a range of conditions, including where straw has been spread and left on the surface.

In two field experiments in the Sacramento Valley – one on a loam soil and one on a clay soil – the maximum rice yield (i.e., yield at the optimal N fertilizer rate) on covercropped plots exceeded by 2 to 5 cwt/acre the maximum yield on non-covercropped plots. This suggests a non-nitrogen related benefit of covercropping. There is some evidence to suggest that covercropping in a rice rotation increases soil organic matter, contributes to soil tilth, and influences rice straw breakdown, although long-term experiments have not been conducted to confirm this.

The energy consumed in planting and incorporating the covercrop is offset by the energy saved by the reduction in the use of synthetic N fertilizers, the manufacture of which uses large amounts of natural gas or electricity.

The economic return on covercropping in a rice rotation is often not favorable. However, under optimal circumstances, covercropping can pay off, even in the short run. Therefore growers are encouraged to experiment.

FURTHER INFORMATION ON COVERCROPPING IN RICE PRODUCTION

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