YIELD RESPONSE OF SUGAR BEET IN CROPPING SYSTEMS AT DIFFERENT INPUT LEVELS

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ABSTRACT

Two crop managements were compared on a 4-year rotation: sugar beet, grain sorghum, soybean and wheat. The trial, still under way, was carried out on a farm scale over 10 years (1993 to 2002). Traditional husbandry involved high input of energy (soil tillage, fertilisers) and of chemicals (weed and disease control); integrated husbandry involved lower input levels (48% less energy for tillage, 32% less N-P input, 50% less chemical input). Since 1997, two cross-combinations were added to the basic scheme: traditional husbandry x low N-rate and integrated one x high N-rate.

In terms of yield, low input level in sugar beet could hardly match the performance of high input level, while the remaining crops proved more responsive to integrated farming. In terms of net income, integrated husbandry in sugar beet filled the gap to traditional one, thanks to considerable cost savings.

The split scheme adopted since 1997 highlighted that, by simply applying high N-rate to integrated husbandry, sugar yield was restored to high level. The gain in beet quality associated with low input turned out to be quite moderate, in the very good-quality farm where the trial was carried out.

Over the whole rotation, input reductions allowed significative direct cost savings, which in turn gave a 11% increase in net income. Energy savings were more substantial, and the corresponding output/input ratios greatly improved.

It is perceived that in sugar beet rotations a sensible decrease in input level is possible, while at the same time assuring profitability and improving the cropping system efficiency to convert subsidiary energy into valuable vegetable productions.

ABRÉGÉ - RENTABILITÉ DE LA BETTERAVE À SUCRE DANS DEUX SYSTEMES DE CULTURE CARACTÉRISÉS PAR DES NIVEAUX DIFFÉRENTS D'APPORT

L'étude porte sur la comparaison de deux techniques différentes de gestion des cultures dans le cadre de la rotation quadriennale de : betterave, sorgho à grain, soja et blé. L'essai, toujours en cours, a été conduit au niveau d'une exploitation agricole pendant 10 ans (1993 – 2002). La technique traditionnelle était caractérisée par des apports élevés en énergie (travail du sol, fumure) aussi

bien qu'en produits chimiques (lutte contre les mauvaises herbes et les maladies) ; la technique intégrée, par contre, comportait des apports plus réduits (48% d'énergie en moins pour le travail du sol, 32% en moins pour N et P, 50% en moins de produits chimiques). À partir de 1997, on a ajouté deux combinaisons croisées au schéma de base : technique traditionnelle x niveau réduit de N et technique intégrée x niveau élevé de N.

Pour ce qui est de la rentabilité, dans le cas de la betterave à sucre, l'apport réduit a à peine atteint le niveau de performance obtenu par un apport élevé, tandis que les autres cultures ont obtenu des performances meilleures avec la gestion intégrée. En termes de revenu net, dans la betterave à sucre, la gestion intégrée a pu combler la lacune productive par rapport à la technique traditionnelle grâce à des économies importantes de coûts.

Le schéma adopté à partir de 1997 a mis en évidence que la seule application d'une dose élevée d'azote à la technique intégrée est suffisante pour faire remonter la production en sucre à un niveau élevé.

L'amélioration en termes de qualité de la betterave à sucre, dans le cas d'un apport réduit, a été assez modeste dans l'exploitation où les essais ont été conduits, vu qu'elle était déjà caractérisée par une très bonne qualité de production.

Dans l'ensemble de la rotation, les réductions en apport ont permis des économies importantes en termes de coûts, ce qui, à son tour, a entraîné une augmentation de 11% du revenu net. Les économies d'énergie ont été encore plus importantes et les rapports production/apport correspondants ont enregistré une amélioration remarquable.

L'étude a mis en évidence le fait qu'une réduction raisonnable du niveau d'apport dans les rotations de la betterave à sucre est possible, tout en assurant la rentabilité de la culture et en améliorant l'efficacité du système de culture au moyen d'une conversion de l'énergie supplémentaire en production végétale d'une certaine valeur.

KURZFASSUNG - RENTABILITÄT VON ZUCKERRÜBEN IN ANBAUTEN MIT UNTERSCHIEDLICHER EINBRINGUNG

Zwei verschiedene Anbauverfahren wurden über vier Jahre in einem Rotationsverfahren verglichen: angebaut wurden Zuckerrüben, Körnerhirse, Weizen. Die noch laufende Testreihe erstreckt sich über 10 Jahre (1993 – 2002) und erfolgte auf betrieblicher Ebene. Das traditionelle Anbauverfahren erforderte eine hohe Einbringung von Energie (Bearbeitung der Felder, Dünger) und Chemie (zur Kontrolle von Unkraut und Krankheitsbefall); das integrierte Verfahren erforderte eine geringere Einbringung (48% weniger Energie für die Bearbeitung, 32% weniger N-P und 50% weniger chemische Produkte). Ab 1997 wurden dem Grundschema zwei gekreuzte Kombinationen hinzugefügt: traditionelle Anbauverfahren x geringer Anteil von N und integriertes Verfahren x hoher Anteil von N.

Der Produktionsaustrag ergab, dass eine geringe Einbringung bei der Zuckerrübe kaum an die Ergebnisse der hohen Einbringung heranreicht,

während die anderen Anbauten besser auf das integrierte System reagiert haben. Das integrierte Anbauverfahren ergab einen Nettoaustrag der Zuckerrübe, durch den der Produktionsunterschied zum traditionellen Verfahren aufgrund der erheblichen Kosteneinsparungen ausgeglichen wurde.

Das ab 1997 eingeführte Kreuzschema hat ergeben, dass die zeitliche Verteilung des hohen Stickstoffanteils im integrierten Verfahren zu einem hohen Zuckergehalt der Rübe führte. Die Qualitätsverbesserung der Zuckerrübe im Verfahren mit geringer Einbringung war im Versuchsbetrieb durch eine hohe Ausgangsqualität relativ niedrig.

Im Rahmen der Rotation ergaben die Kürzungen in der Einbringung erhebliche Kosteneinsparungen, die zu einer Steigerung des Netto-Betriebsergebnisses von 11% geführt haben. Die Energieeinsparungen lagen noch höher und die entsprechenden output/input Verhältnisse konnten erheblich verbessert werden.

Das Ergebnis zeigt wie eine vernünftige Reduktion des Einbringungsniveaus in der Rotation von Zuckerrübenanbau möglich ist bei gleichzeitiger Rentabilität und einer verbesserten Effizienz des Anbausystems durch eine zusätzliche Zuführung von Energie in hochwertige Pflanzenproduktionen.

INTRODUCTION

Sugar beet is a crop that cannot be grown on the same soil very often, in order to mitigate soil pests and diseases. For this reason, three- and four-year rotations are most common in sugar beet areas throughout the world. The study of the beet crop as part of a rotation is of great interest and gives hints at how to fine-tune the whole rotation in terms of attainable yields, costs, input efficiency.

MATERIALS AND METHODS

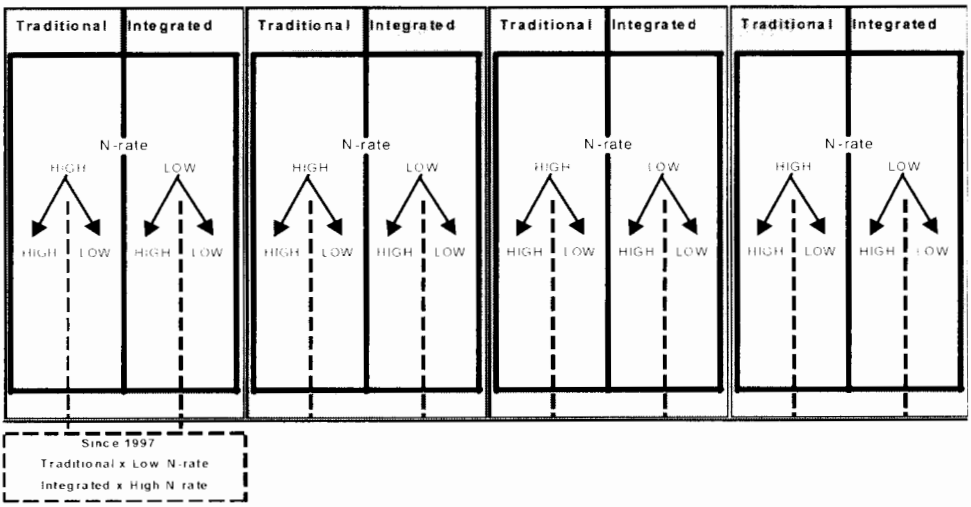
In the ten years 1993 to 2002 a four-crop rotation was established on ten hectares at Cà Bosco farm, near Ravenna (Northern Italy). The four crops were sugar beet, grain sorghum, soybean and wheat, all present in every year and rotating on four plots. Each crop was splitted into two parts at different input levels: a high one, reflecting the traditional husbandry ensuring a good yield regardless of costs; and a low one, representing an integrated husbandry, allowing significative savings in soil tillage, fertilisers and pesticides, on the base of recent experiences in consevative tillage and in guided protection, weed control and fertilisation.

In the years 1997 to 2002 two cross combination were added by splitting the basic scheme: traditional husbandry (tillage, protection) x low N-rate and integrated one x high N-rate (fig.1).

RESULTS AND DISCUSSION

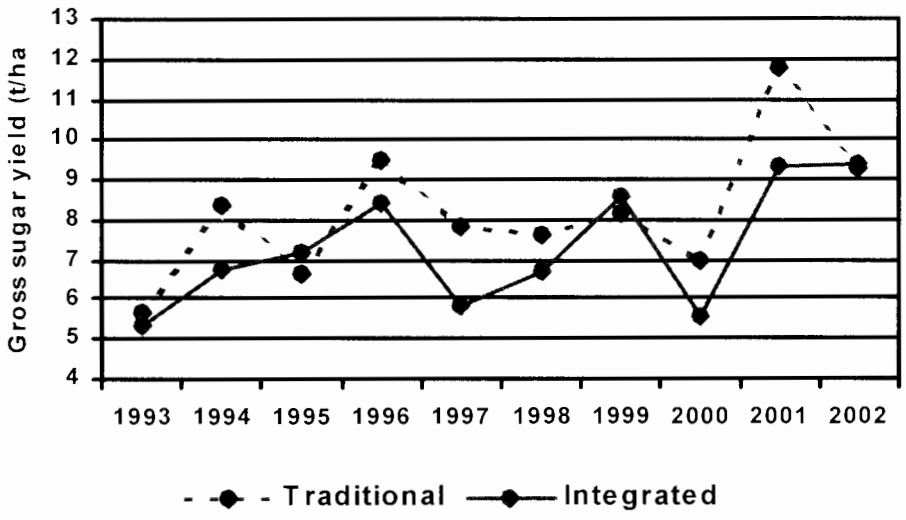
In the years 1993 to 2002 sugar yield ranged from 5 to 12 t/ha, according to the season's potential (fig. 2). Traditional husbandry prevailed on integrated one seven years out of ten. The average difference over the decade was 0,9 t/ha,

Figure 1: Experimental Scheme



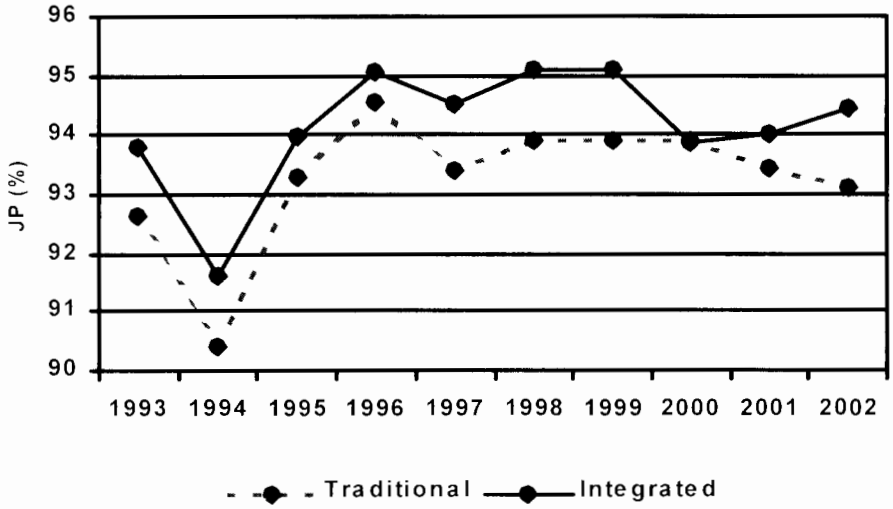
corresponding to +12%. No trend in time seems to exist: large yield gaps, about 2 t/ha or more, occurred repeatedly from the beginning to the end of the trial. Likewise, differences did not seem to depend on the yield potential of the year. It is perceived, therefore, that large differences were not due to a lack of experience in the set-up of integrated farming.

Figure 2: Sugar Yield: Traditional and Integrated husbandry.



As for quality, a reversed pattern was observed: integrated sugar beet growing performed better than traditional one in 9 years out of 10 (fig. 3).

Figure 3: Juice Purity: Traditional and Integrated husbandry.



The average difference was quite significative (0,9 % of juice purity), but it must be considered that in the traditional crop, quality was already set at a very high level. It is perceived that integrated farming positively affected quality thanks to lower N-applications, as it is confirmed by a lower level of N impurities in the roots (table 1).

Table 1: Amino-N: Traditional and Integrated husbandry. Average 1993 to 2002.

The association between better quality and lower yield highlighted the role of N-nutrition in integrated farming. In fact, in the years 1997 to 2002 the split-scheme (fig. 4) showed that, by simply applying high N-rate to the integrated crop, sugar yield was restored to high level and, more important, net income benefitted even more (fig. 5), thanks to cost savings.

Sugar beet was the only of the four crops to show sensitivity to N-nutrition; the other three performed more evenly, regardless of input level. The overall results of the rotation over the decade (fig. 5) highlight a slight decrease in gross revenue, but a significative increase in net income for integrated farming, thanks to considerable cost reductions. In terms of energy balance too, integrated farming proved more efficient than traditional one: in other words, input reductions did not affect output level.

Figure 4: Sugar Yield. Average 1997 to 2002.

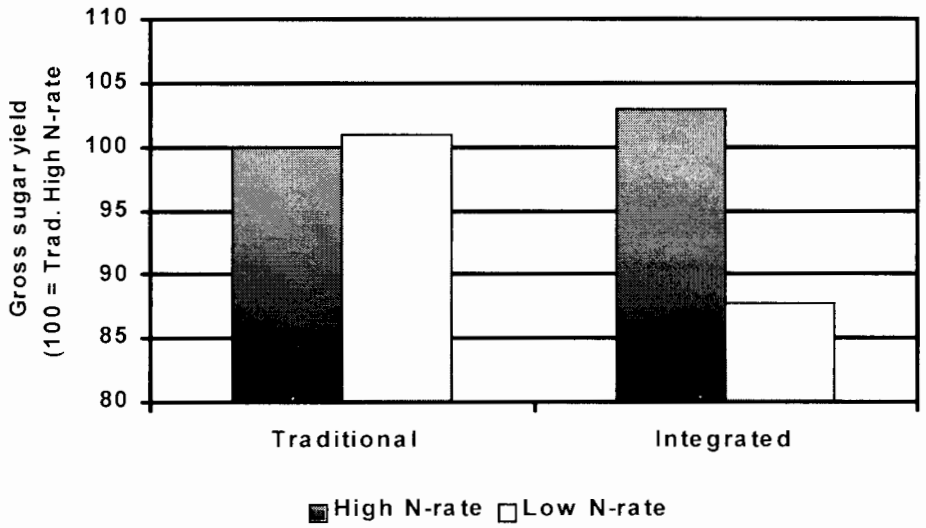
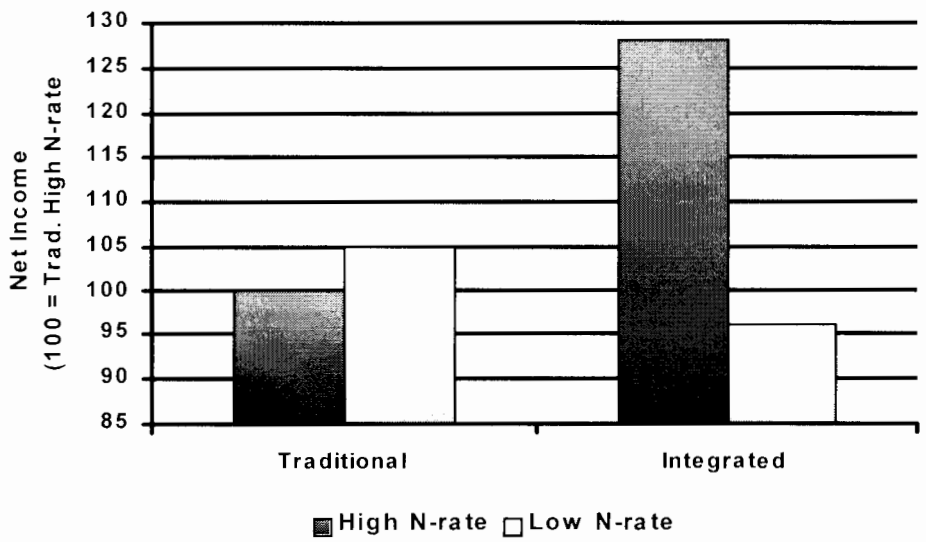


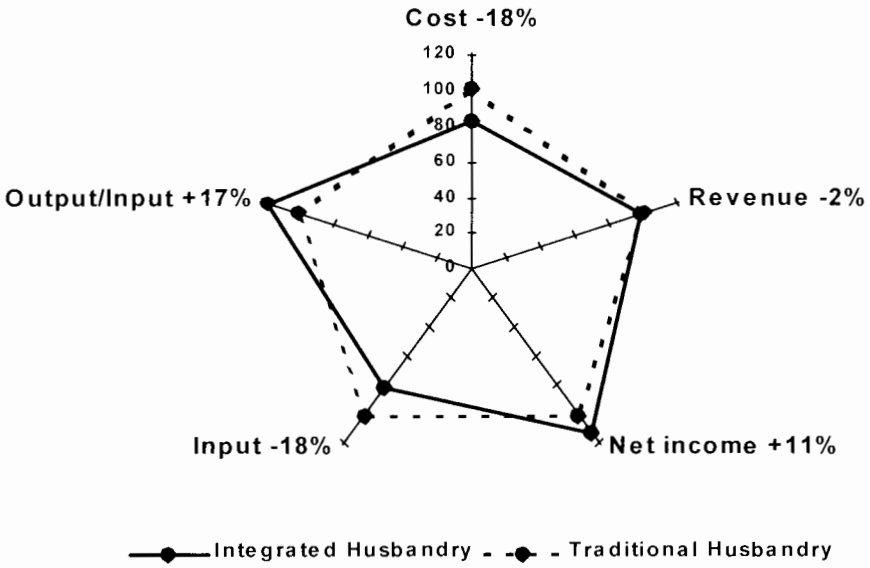
Figure 5: Sugar Beet Net Income - 1997 to 2002.



CONCLUSIONS

- The approach of integrated farming leads to cropping systems featuring lower inputs associated with lower costs and, in perspective, better environmental respect.

Figure 6: Integrated vs Traditional husbandry in a 4-crop rotation over 10 years.



- In this framework, sugar beet proved a sensitive crop: husbandry must be fine-tuned with great accuracy, in order to avoid yield losses without corresponding quality benefits. More in detail, it appears that not all inputs may be curbed simultaneously to the level they can stand when reduced singularly.
- For the grain crops (wheat, sorghum, soybean), there is a lower sensitivity to this problem, then a wider margin of reduction avoiding the risk of negative consequences.
- Over the whole rotation, integrated farming improved both profitability and the efficiency to convert energy into valuable productions.

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