

32 profitability, with parsimony in the use of external inputs and lower production costs. The
33 purpose of this study is to analyze the environmental performance of coconut production in
34 different technological contexts, as to identify the conditions and factors by which changes
35 towards ecologically intensive practices have had greater potential to promote sustainability.

36 37 **MATERIAL AND METHODS**

38 A wide variety of methodological approaches have been developed to meet a growing
39 international demand for sustainability indicators (SANCHEZ AND MATOS, 2012; OLDE *et*
40 *al.*, 2016.). In this research, we seek to identify the technological intensification contexts in
41 which the highest environmental performance gains are observed in coconut production,
42 favoring the recommendation of management practices that promote sustainability. For this
43 purpose, the APOIA-NovoRural indicators system has been applied (RODRIGUES AND
44 CAMPANHOLA, 2003) as an adequate environmental assessment tool, applicable onto the
45 variety of production contexts and technology adoption levels observed, and considering the
46 diversity of environments and local coconut production characteristics.

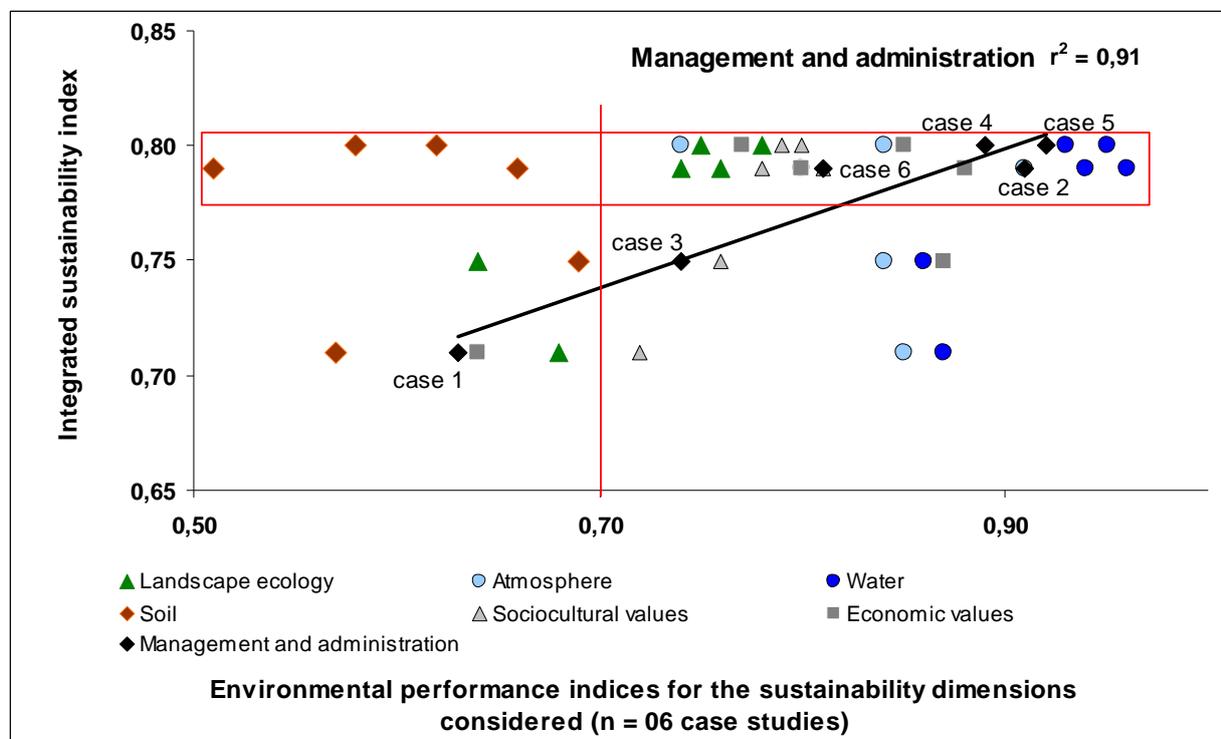
47 The APOIA-NovoRural system consists of 62 indicators grouped in five sustainability
48 dimensions, namely: (i) Landscape ecology, (ii) Environmental quality (air, water and soil),
49 (iii) Socio-cultural values, (iv) Economic values and (v) Management and administration.
50 Organized into a set of multi-attribute weighting matrices (scale normalized from 0 to 1, with
51 baseline modeled in 0.7), the integrated indicators allow quantitative and objective analysis of
52 environmental performance, in field inspections carried out with analytical instrumentation
53 and management data obtained with the farmers (RODRIGUES *et al.*, 2010).

54 For the current study, six reference rural establishments partners with Embrapa in technology
55 development and transference programs were selected to carry out case studies. These reference farms
56 showed different levels of intensification and diversification, varied technology adoption capacities,
57 and entrepreneurial strategies from family businesses to large-scale enterprises. Field data surveys
58 took place between July 2013 and November 2014, and results from each case study were reported
59 back to the rural establishment managers in 'environmental management reports', containing all
60 documentation on environmental conditions and recommendations towards sustainable production.

61 62 **RESULTS AND DISCUSSION**

63 The analysis of the six case studies pointed out the great influence of environmental
64 conditions, particularly climate and soil fertility constraints, on the environmental
65 performance of farms (Figure 1). Main recommendations included adjustments and

66 parsimony in the application of fertilizers, as to avoid excesses that result in financial losses
 67 (case of phosphorus) and water contamination risks (case of nitrogen). Also, corrections and
 68 increase in the supply of organic matter, to correct natural deficiencies and improve nutrient
 69 and water retention capacity in the naturally very sandy soils.



70 **Figure 1** - Results of environmental indicator analyses in reference coconut production farms.
 71 The four rural establishments characterized as 'ecologically intensive' are highlighted (red
 72 frame), and cases studies are identified for the Management and administration dimension.
 73

74 In general, the other indicators related to the Environmental quality dimensions were
 75 suitable in the studied farms, such as compliance with landscape management requirements,
 76 excellent water quality and lack of noticeable atmospheric emissions. The Economic values
 77 dimension proved to be generally quite adequate, although with a situation of negative
 78 performance due to particularly severe drought in recent years. Socio-cultural values
 79 indicators were rather favorable, given the provision of training to employees, very good
 80 employment and benefits conditions, and access to basic services. The Management and
 81 administration dimension proved to be closely dependent on the entrepreneurial and
 82 productive contexts of the studied establishments, both for those dedicated to coconut
 83 monocultures as well as the diversified ones.

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CONCLUSIONS

86 A close correlation was observed between the Management and administration
 87 dimension and the integrated sustainability indices (see trend line, highlighted in Figure 1).
 88 This result supports the hypothesis according to which the sustainability of rural activities in
 89 general, as well as for coconut production in particular, can be strongly favored by the
 90 adoption of environmental management tools, such as the APOIA-NovoRural system. By the
 91 same token, the environmental performance of the rural establishments dedicated to coconut
 92 production was much improved when the productive context was more diversified and
 93 integrated, attesting to the value of technology adoption and ecological intensification as
 94 strategies to improve sustainability.

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