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Agroforestry adoption and risk perception by farmers in Sénégal

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Abstract. Research was conducted during a 10-month period (August '89—May '90) in Arrondissement de Koumpentoum, Région de Tambacounda, Sénégal to evaluate factors influencing the adoption and farmer perceptions of the risks associated with agroforestry. Variables have been identified that are significant to agroforestry adoption and predictive equations are formulated. Land ownership and labor availability are identified as the two most significant factors which contribute to agroforestry adoption. They contribute to the sense of security of a producer thereby reducing the aversion to risking agroforestry adoption.

Précis. On a fait des recherches pendant une période de dix mois (du mois d'août 89 au mois de mai 90) dans l'arrondissement de Koumpentoum, Région de Tambacounda au Sénégal pour évaluer les facteurs qui influencent l'adoption de l'agroforesterie et la perception du fermier du risque associé à l'adoption d'agroforesterie. On a indentifié les variables qui sont importantes à l'agroforesterie, et les équations prophétiques sont formulées. Le droit de propriété et la disponibilité de travail sont indentifiés comme étant les deux facteurs les plus importants qui contribuent au choix de l'agroforesterie. Ces facteurs contribuent au sentiment de sécurité d'un producteur, et de ce fait, ils réduisent l'aversion pour le risque de l'adoption de l'agroforesterie.

Sénégal is characterized by rapid population growth, low agricultural productivity, increasing demands on agricultural and forest resources and great fluctuations in annual precipitation. These factors all have contributed to deforestation and environmental degradation. The adoption of agroforestry systems holds potential for slowing deforestation and environmental decline for a country such as Sénégal. Production of wood for fuel and construction, fodder for animals and soil nutrient/ erosion control are potential benefits of agroforestry adoption. This study identifies land ownership and labor availability as the most predominant factors affecting the adoption of agroforestry practices. The relationship of these and other factors of adoption to farmer characteristics and farmer perceptions of various forms of capital and consumable commodity risks are examined.

Agroforestry adoption or non-adoption is a function of the agroforestry practice(s) proposed, perception of need, the availability and distribution of factors of production and perception of risk. Like any other technology, agroforestry must appear practical and beneficial in both human and economic terms to warrant adoption. Agroforestry technologies being attempted in the study area include live fences, windbreaks and home gardens.

Adoptability of a technology is greatly enhanced when the proposed technology holds potential to solve 'perceived problems' in particular locations [9]. A farmer's attitude towards agroforestry adoption is affected by his/her perception of need for and practicality of the technology in the given social, economic and biological environment. This perception is dependent on the information available to the individual. Both the need for a technology and awareness of the potential benefits of adopting the technology must be present for eventual adoption to occur [15].

1. Selection of study area

Région de Tambacounda in Sénégal was selected as the general area in which the study would be conducted at the suggestion of Rodale International (RI). Colleagues at RI provided introduction opportunities to national and international organizations which have an interest in agroforestry projects in Sénégal. The involvement of Catholic Relief Services (CRS) with grass-roots farmer associations in Région de Tambacounda was complementary to the research goals. The Arrondissement de Koumpentoum was selected as the specific study area as a result of on-going agroforestry collaboration between CRS and Arrondissement farmer associations.

Except for dry season vegetable production, crops are rainfed. Annual precipitation varies widely but averages approximately 600 mm [4]. Peanut production is the major cash crop of the study area. Subsistence activities include livestock management (mostly cattle and small ruminants), millet and sorghum production and vegetable gardens. Soils are unleached or weakly leached tropical ferruginous (Ustipsamments) soils [8]. Agroforestry extension is not currently included in government programs for the study area. However, agroforestry information is increasingly available through NGO projects and local farmer organizations.

Criteria for village selection was based on the presence in a village of a group of farmers and/or at least one farmer employing at least one agroforestry practice. These villages were identified with the assistance of farmer associations. The villages included in this study range in population from approximately 70 to 1,800 inhabitants. Wolof is the predominant ethnic group for the area and in most villages (Table 1). However, one village, Kissang, is predominantly Mandinka and another, Koundiao Souaré, is predominantly Fulani (Peul).

Interviews were conducted with 46 farmers in 12 villages in the study area during the ten-month period of August—May, 1989—90. Initial attempts were made to pair agroforestry adopter and non-adopter respondents on the basis of equitable land holdings, production output and farmer association membership/non-membership. The dearth of information on

Table 1. Predominant ethnic groups, population of villages selected and number of adopters and non-adopters interviewed, by zone and village.

Village	Predominant ethnic group	Approximate population (number)	Non-adopters interviewed (number)	Adopters interviewed (number)
		Southern Zone		
Diam-Diam	Wolof	1,130	4	2
Fass N'Diayene	Wolof	100	1	0
Kissang	Mandinka	300	3	2
Koumpentoum	Wolof	1,800	1	0
Koundiao Souaré	Fulani	500	0	5
Thialène	Wolof	340	4	5
		Northern Zone		
Boussoura	Wolof	100	1	0
Darou Mana	Wolof	300	2	6
Darou Saloum	Wolof	150	3	1
Darou Thiéken	Wolof	130	2	0
Diokoul Thioukoul	Dialonke	150	1	1
Syll Birame	Wolof	70	1	1
			23	23

individual land holdings and production output resulted in criteria for farmer selection based only on farmer association member/non-member and agroforestry adoption/non-adoption. There was little or no difference between the southern and northern zones in terms of the presence of a farmer association group or the distance to a seedling source in 1989 [2]. Through use of a questionnaire information about producers, their family, household, assets and production history was gathered. The information collected was then categorized into major areas pertinent to production enterprises in the study area.

2. Reasons for adoption / non-adoption

Agroforestry adoption has potential for functioning in a natural resource conservation role as well as serving in a production role providing benefits to agricultural enterprises [1]. The 'production role' contributions can combine with 'service role' contributions of fodder, food, fuelwood, building material and other raw materials [10]. The reasons cited by farmers interviewed for the decision to adopt or not to adopt agroforestry are given in Table 2. They were not asked to rank their reasons for adoption or non-adoption.

The predominant reason given for agroforestry adoption was to obtain tree products (wood, fruit/leaves) for marketing. Home consumption of these

Table 2. Reasons for agroforestry adoption and non-adoption*.

Reasons	Adopters (number)	Non-adopters (number)
Why adopt?		
Construction wood	5	—
Firewood	0	—
Fruit/leaves	8	—
Environmental concern	5	—
Windbreak/live fence	6	—
Soil/crop benefits	9	—
Sell products	9	—
Use/consume products	4	—
Delineate land	3	—
Felt obligated by EGA/K or family	3	—
Why not adopt?		
Lack of information	—	8
Crop/operations interference	—	2
Lack of money	—	9
Lack of seedlings	—	10
No fencing	—	2
Past mortality	—	3
Lack of land	—	2
Lack of land control	—	2
Land too distant	—	1
Lack of labor	—	1

* Some respondents reported multiple reasons; no order of importance is indicated.

products and environmental/ecological reasons for adoption was less often cited as a motivation. This fact illustrates the need to identify tree species which can satisfy the economic wishes of adopters while maximizing the system contributions to family nutrition and environmental and soil/crop benefits. Non-adopters cited problems of seedling availability and affordability which points at the need for continued efforts to improve nursery production and seedling distribution abilities [3]. Seedling pricing and credit policies and programs should receive further analysis.

One may speculate on other potential reasons for a decision to adopt or not to adopt agroforestry in the study area. The impact of social and/or political pressures can logically be said to exist but is difficult, if not impossible to quantify. Farmer associations, like all institutions, are composed of people with preferences and biases. The possibility of information and resources being directed toward a certain network of individuals should not be neglected. This type of action could restrict the potential of agroforestry adoption among those outside such a network. On the other hand, some individuals may have their motivation for adoption based on an attempt to please those in the network, thereby receiving some kind of reward or recognition for their efforts.

3. Distinguishing between adopters and non-adopters

Models were developed to enable one to distinguish between farmers who would choose to adopt agroforestry and those who would be less likely to adopt. The dependent variable (Y) represents the adoption (Y = 1) or non-adoption (Y = 0) of one or more agroforestry practice(s) by agricultural producers. The dependent variable is assumed to be a linear function of a series of independent variables (x_j):

$$L = a + b_1 x_1 + \ldots + b_k x_k;$$

where k is the number of independent variables (listed below by categories) selected such that L attains high values for adopters and low values for non-adopters and makes as good a discrimination as possible.

The following variables were selected based on the intuitive model that agroforestry adoption or non-adoption is a function of family/personal characteristics and measures of wealth such as land availability/fragmentation, cropping history and animal ownership.

Family/personal

- M (member of a farmer association)
- AGE (mean age of farmers)
- NW (number of wives, male farmers only)
- RW (literacy)
- CH1 (children $<=$ 5 years)
- CH2 (children 6—20 years)
- CH3 (girls 6—15 years)
- CH4 (boys $>=$ 21 years)
- CH5 (girls $>=$ 16 years)
- NAM (other household adult males)
- NAF (other household adult females)

The intuitive model suggests that family/personal characteristics such as age, organizational affiliation, education and the availability of family and household labor are all variables which could affect the decison to adopt a new technology.

Land

- NPOWN (number of plots owned)
- AVES (average plot size)
- THA (total hectares)

The structure of land holdings has been shown to affect decision making

[11]. This fact suggests that agroforestry adoption decisions may be affected by the total land area available to an individual as well as by the number and relative size of plots available.

Crop history

— V1	(variance of gross product value)
— TNET	(mean net product value)
— V2	(variance of net product value)
— CHA1	(mean hectares of peanuts)
— V6	(variance of hectares of peanuts)
— V7	(variance of total yield of peanuts)
— YHA1	(mean yield/ha of peanuts)
— V8	(variance of yield/ha of peanuts)
— CHA2	(mean hectares of millet)
— V3	(variance of hectares of millet)
— V4	(variance of total yield of millet)
— YHA2	(mean yield/ha of millet)
— V5	(variance of mean yield/ha millet)
— MEANTC	(mean number of crops per year)
— MYERS	(years that millet was grown)

Cropping history is a reflection of the wealth and reliability of income of a producer. As such the intuitive model suggests that land area devoted to crops, yield of crops, variation of crop yields and crop values all contribute to the perception of risk and adoption decisions. Therefore, producers were surveyed about their cropping history over a five-year period (1985—1989). Means and variances for adopters and non-adopters were calculated.

Animals

— C	(number of cattle)
— H	(number of horses)
— D	(number of donkeys)
— SML	(goats + sheep = small ruminants)

The number and species of animals owned by a producer indicate not only a measure of wealth but suggest differences in enterprise management approaches. These factors can be assumed to affect the decision making process of a producer.

The variables were subjected to a number of tests to determine their significance relative to agroforestry adoption, simple correlations between variables and any need for variable transformations. A stepwise discriminant analysis was then performed, predictive equations obtained and confidence intervals calculated. Using the predictive equations and confidence intervals, the sample data were used to evaluate the accurate prediction of agroforestry adoption or non-adoption. However, it must be noted that caution should be used when interpreting the results of the analysis due to the small sample size of 46 observations.

3.1. *General linear model*

The general linear model was utilized for descriptive purposes to describe the relationship of each independent variable to the two basic categories (adopter/non-adopter) of respondents. Using the least squares method, each independent variable (x_i) is regressed against the dependent variable (Y) to determine its level of significance to agroforestry adoption or non-adoption [12].

All independent variables were tested at the 0.05 confidence level to determine the significance of each variable, taken by itself, on the adoption or non-adoption of agroforestry. The measures of F-Value, probability > F and R-square were reported for each independent variable. The number of plots owned (NPOWN) was shown as the single significant variable to agroforestry adoption. Therefore, a more detailed procedure was implemented.

3.2. *Stepwise discrimination analysis*

To meet requirements for this analysis, the assumption was made that adopters sampled in this study were selected from the total population of all possible adopters in Arrondissement de Koumpentoum. Under this assumption sample data were substituted. Therefore, the use of equal prior probabilities became a neutral prior, and discriminant analysis became possible [6].

The stepwise discriminant analysis procedure chooses variables which most significantly contribute to the dependent variable through forward selection and backward elimination. Tests of significance are measured by use of Wilks' ratio of determinants (Wilks' lambda) [7, 14]. The default confidence level of 15 percent was used for variable retention.

The discriminant analysis procedure was used to develop the linear discriminant analysis procedure for each of the two groups. The predictive equations provide criteria upon which to classify observations into groups [12]. The groups in this research are agroforestry adopters and non-adopters.

The effectiveness of the predictive equations were then measured through use of the classificatory discriminant analysis procedure. This procedure uses the predictive equations to classify each of the sampled observations as adopters or non-adopters. The number and percent of correctly classified observations are reported and the misclassified observations are identified.

The resulting discriminant variables selected for inclusion in the predictive equations for agroforestry adopters and non-adopters are:

NPOWN — number of plots owned
H — number of horses
NAM — other adult males in household
CH4 — boys >= 21 years (children of producer)
YHA1 — mean yield kg/ha of peanuts
CH5 — girls >= 16 years (children of producer)

The stepwise discriminant analysis procedure selected the above variables through use of the likelihood ratio criterion (Wilks' lambda). Predictive equations showing the determinant variables selected by the stepwise discriminant analysis procedure, the magnitude and direction of variable coefficients as determined by the linear discriminant function procedure, and the confidence intervals (0.05 confidence level) for adopters and non-adopters are shown in Table 3.

Table 3. Discriminant variables in order of selection, partial R^2, Wilks' lambda and probability > lambda[1].

Variable	Partial R^2	Wilks' lambda	Prob. > lambda
NPOWN (plots owned)	0.0993	0.9007	0.0329
H (number of horses)	0.1182	0.7943	0.0071
NAM (household adult males)	0.0688	0.7396	0.0051
CH4 (male children >= 21 yrs)	0.0546	0.6992	0.0047
YHA1 (yield kg/ha peanuts)	0.0649	0.6538	0.0035
CH5 (female children >= 16 yrs)	0.0825	0.5999	0.0019

[1] — 0.15 confidence level.

3.3. *Adoption*

The equation which defines the criteria for classification of observations into the agroforestry adoption category is:

$$\begin{aligned}\text{Adoption} = & -8.09842 + 1.53185\,(\text{NPOWN}) - 1.23395\,(\text{H}) \\ & + 1.21244\,(\text{NAM}) + 2.72967\,(\text{CH4}) + 0.00829\,(\text{YHA1}) \\ & - 1.50029\,(\text{CH5})\end{aligned}$$

Confidence level (0.05): $>= 6.2420$

From this equation one may be 95% confident that a producer operating in Arrondissement de Koumpentoum will be favorably inclined toward agroforestry adoption if he/she scores at or above the one-sided confidence interval using the identified variables and the corresponding signs on the respective regression coefficients. This equation indicates that agroforestry adoption in the local area is positively and strongly influenced by the number of plots owned by an individual producer, the number of adult males in the household and the number of his/her adult male children living in the compound. The mean per hectare yield of peanuts over the past five years is also positively associated with agroforestry adoption, but to a much lesser degree than the other positive variables.

Number of plots owned (NPOWN) was selected as the determinant land resource variable through the stepwise analysis procedure. Further, NPOWN was highly correlated with total hectares (THA) and with average plot size (AVES). The positive sign on the regression coefficient combined with high correlation with other land variables supports the assumption that land security contributes favorably to the adoption of agroforestry.

Number of adult males (CH4) and adult females (CH5) were found to be significant to the adoption or non-adoption of agroforestry. Adult males are shown to have the highest positive coefficient of significance to adoption. Their significance to adoption can be attributed to the important contribution to production and wealth accumulation. More land, experience in production, and labor availability all contribute to perceived security and increased willingness to accept the risk of agroforestry adoption on the part of the adopter. Adult female offspring remaining in the compound are shown to have a negative regression coefficient to agroforestry adoption. The negative sign can be attributed to the fact that, although she does contribute to her fathers' production enterprises, her value to production is less than the value of her dowry. In economic terms, she is a net liability to her father until she marries and he gains her dowry as an asset. The perceived liability may contribute to unwillingness to accept the risk of agroforestry adoption. The number of adult males in the household (NAM) was selected as a determinant variable for agroforestry adoption. The contribution of NAM to adoption/non-adoption can be accounted for in similar terms as cited for inclusion of the number of adult male children (CH4). The adult males in the household, their wives and children, increase the total resources available to the compound and to the producer in question. More land, more labor, more production for market and consumption all contribute favorably to agroforestry adoption.

The number of horses (H) also was found to be a determinant variable relevant to agroforestry adoption. However, the regression coefficient was negative. The negative regression sign for horses indicates that horse ownership is an impediment to agroforestry adoption. Because horses are symbols of wealth, providers of traction and of transportation, one would assume the opposite to be true. The negative coefficient might be explained in terms of cropping operations. Horses are the most effective traction animal and are used most commonly in the production of peanuts and millet. These are extensive crops most often grown on the larger, cleared plots. Farmers have cleared these plots of as many trees as possible (some species are protected by law) to reduce shading and for ease of crop operations. The cropping operations for these crops utilize production implements which are impeded by obstacles such as tree roots. Further, trees can hamper the maneuverability of traction animals.

Yield per hectare of peanuts (YHA1) was determined to be the most significant cropping variable relevant to agroforestry adoption. The regression coefficient is positive but very small. The small regression coefficient of

YHA1 indicates that cropping variables are less important to agroforestry adoption than are variables which measure land and labor resources.

To summarize, the more plots owned, the more adult males in the household, the more adult sons living in the compound and the higher the per hectare peanut yield, the more likely the producer will choose to adopt agroforestry. Conversely, the more horses owned by the compound, the less likely agroforestry will be seriously considered.

3.4. *Non-adoption*

The equation which defines the criteria for classification of observations into the agroforestry non-adoption category is:

$$\text{Non-Adoption} = -4.03696 + 0.70237\,(\text{NPOWN}) - 0.42462\,(\text{H}) + 0.81388\,(\text{NAM}) + 1.45168\,(\text{CH4}) + 0.00614\,(\text{YHA1}) - 0.41218\,(\text{CH5})$$

Confidence level (0.05): $<= 5.5296$

The predictive equation for non-adoption of agroforestry in the local area uses the same variables as the equation for predicting agroforestry adoption. The variables have the same signs as the predictive equation for agroforestry adoption; however, the magnitudes of the coefficients are considerably lower. One may be 95% confident that a producer will be unlikely to be favorably disposed to adopt an agroforestry practice if he/she scores at or below the specified one-sided confidence interval using the predictive equation for agroforestry non-adoption.

The data set reflecting characteristics of respondents who are agroforestry adopters was used with the predictive equations for agroforestry adoption and non-adoption, and the corresponding one-sided confidence intervals, to determine the accuracy of prediction. The data set containing information about agroforestry non-adopters was similarly subjected to evaluation by the predictive equations for adoption and non-adoption using the corresponding one-sided confidence intervals for each equation. Some 87% of the respondents who are agroforestry adopters were accurately predicted to be adopters. In the case of non-adopters, the predictive equation correctly classified 82.6% of the sample as non-adopters (Table 4).

The data for respondents who were misclassified were reviewed to determine any particular characteristics and/or patterns common to adopters who were classified as non-adopters and non-adopters who were classified as adopters. No patterns or common characteristics emerged from the review.

Table 4. Discriminant analysis classification summary. Number of observations and percentage classified as adopter and non-adopter.

Adopter (no/yes)		Adopter (no)	Adopter (yes)	Total
	number	19	4	23
No	percent	82.6	17.4	100.00
	number	3	20	23
Yes	percent	13.0	87	100.00

4. Perception of risk

Variables that reflect felt wealth and security in income relate to risk perception [11]. Therefore, variables relating to land, animals, yields and value of production were evaluated to determine differences between adopters and non-adopters. Variance in production and value of production also may affect risk perception [5], thus these variables also were evaluated. Production data on major cash (peanuts) and subsistence (millet) crops were elicited for the five-year period 1985—1989.

The variables identified as being pertinent to risk perception were compared using the mean-variance criterion (Table 5). On the basis of this criterion, it was assumed that producers showing higher mean values for

Table 5. Least square means and significance of difference test[1] of log-transformed variances, by adopters and non-adopters.

Variable	Log-transformed variance		
	Adopters (mean)	Non-adopters (mean)	Probability > t
Gross value	9.4004	9.0931	0.6717
Net value	9.3640	8.9519	0.5645
Ha millet	0.7354	0.5402	0.4951
Millet yield	0.3239	0.3442	0.8911
Millet yield kg/ha	0.0484	0.0402	0.7933
Ha peanut	1.1792	0.7047	0.1846
Peanut yield	1.2542	1.0514	0.5841
Peanut yield kg/ha	0.0959	0.1296	0.5556

[1] — $p = 0.05$.

Note: Variances were log normalized due to unacceptably high standard deviations relative to the means.

resource endowments, yields and net production value would be most likely to risk adoption of agroforestry.

An attraction of agroforestry is the potential for stabilizing a production system [13]. Therefore, it can be speculated that producers showing higher variation in production yields and production value also would be most likely to assume risk of adoption. Because higher variance may indicate that the farmer is accustomed to uncertainty, it can be assumed that he/she would be willing to take on risk in an attempt to stabilize his/her enterprise returns. Conversely, producers with lower mean values of resources and production and lower variance of production value/yields may be assumed to be less likely to risk agroforestry adoption. This is because felt wealth is low, variance of production is low and the producer is unwilling and/or unable to absorb potential failure.

Due to unacceptably high standard deviations of the variances as compared with the means of the variances, the variance variables were log transformed. Although adopters are shown to experience higher variances in most categories identified, none of the measures of variance were shown to be statistically significant to agroforestry adoption either before or after log normalization.

5. Conclusions

Although there is inherent risk associated with interpreting statistical analysis with a small sample size, apparent differences in characteristics between agroforestry adopters and non-adopters in Arrondissement de Koumpentoum are indicated by this study. The group of agroforestry adopters sampled in this research show a number of characteristics which resemble those identified by Rogers [11] as innovators. The most profound of these characteristics are the control of substantial resources and the ability to absorb losses resulting from potential unsuccessful innovations (wealth indicators: land, labor, product value).

Adopters are market producers, however, non-adopters produce for the market as well. Adopters appear more willing to take risks than non-adopters. This is demonstrated not only by the higher wealth indicators for adopters, but by the fact that adopters grow a slightly more diverse number of crops and have indeed risked agroforestry adoption. However, the sample also shows similarities to those identified by Rogers [11] for the general group defined as 'later adopters'. Later adopters have the advantage of the 'demonstration effect' of implemented and functioning innovations. That the sampled adopters hold some characteristics of later adopters may perhaps be explained by the fact that EGA/K group agroforestry plots have served as a demonstration effect in some Arrondissement de Koumpentoum villages.

Adopters were found to have the most land and labor availability. These variables represent resource control and production potential, both of which can be translated into a felt wealth and contribute to the sense of security of a producer which have been shown to reduce the aversion to risking technology adoption [11].

High per hectare peanut yields appear to encourage adoption. This may be due in part to the positive monetary effects of high returns and the resulting ability to reduce labor and land area required to gain a certain level of income from peanuts. This would imply that money, land and labor could be devoted to agroforestry enterprises. On the other hand, the negative influence of horse ownership may be attributed to the fact that more land may be used in a manner not conducive to agroforestry as more horses are available for traction. The negative coefficient for adult female children still living in the compound may reflect the as yet unrealized wealth in the form of a dowry which is obtained upon the marriage of a daughter. This unrealized wealth, plus the increased labor supplies by the adult female child for crop production may combine to discourage agroforestry adoption.

6. Implications

Agroforestry information and tree planting campaigns aimed at individual producers may be more effective if land control/ownership, major cropping focus and labor availability is determined for the individuals targeted. Effectiveness of such a campaign might be enhanced if effort is concentrated on those who fit a profile of significant security in land and the family/household structure suggested by the predictive equation for adopters. Further, individuals with a diverse crop production combination and higher per hectare peanut yields, thus with less need for extensive use of land, labor and traction for peanut production, may prove more accepting of agroforestry adoption. Successful agroforestry enterprises achieved with better endowed 'innovators' and/or 'early adopters' may provide a 'demonstration effect' to encourage future agroforestry adoption among lesser endowed potential 'later adopters' or 'laggards'.

Farmers associations have been shown to be contributors to agroforestry information dissemination in Arrondissement de Koumpentoum [2, 3]. Information campaigns encourage agroforestry adoption to association members directly and to non-members indirectly. Association members communicate ideas to their friends and family. Association group plots which include an agroforestry component allow all villagers to experience the 'demonstration effect' of an implemented and operating agroforestry practice. Improvement and expansion of information through farmer associations, as well as through national and international institutions, can encourage more wide-spread adoption of agroforestry. Group plots which include agroforestry component(s) in an increased number of villages may be helpful in informing and persuading rural producers of Arrondissement de Koumpentoum as to the functioning and benefits of agroforestry practices.

Constraints to and motivations for adoption do not necessarily remain constant. Current constraints to an individual adopting agroforestry, such as land tenure issues or seedling availability, may be eased through policy changes in land tenure, nursery establishment and credit subsidies. Further, motivations of current adopters often include income potential from the tree products. As more tree products become available in the future due to continued adoption, potential unrealized financial returns from tree products may prove a discouragement to continued participation in agroforestry. Promotion of alternative species may become advisable for diversity of income potential as well as for environmental/ecological considerations.

Use of the mean-variance criterion to evaluate risk has allowed assumptions to be made concerning the willingness of adopters to accept a degree of risk, and to explain reasons for non-adopters choosing not to take the risk of agroforestry adoption. Some quantification of attitude toward risk could help further explain differences between adopters and non-adopters. Such clarifications might have implications for policy makers in their attempts to expand the number of producers who are willing to increase the sustainability of their production enterprises. Land tenure rights, producer prices, and input availability are among the policy issues pertinent to risk and technology adoption. Policies which create circumstances in which producers become less risk averse could be beneficial for local, regional, national and global well-being.

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